(C)

SHUTTLE OPERATIONS
ZERO BASE COST STUDY

PRESENTATION TO DR. LENOIR
JULY 2, 1991

SHUTTLE OPERATIONS ZERO BASE REVIEW
WITH DR. LENOIR
AGENDA

	TIME	PRESENTER
INTRODUCTION AND OVERVIEW	8:00	J. COSTELLO
MISSION OPERATIONS DIRECTORATE	8:30	J. PETERSEN
LAUNCH & LANDING OPERATIONS	10:30	W. TREAT
LUNCH	12:30	
SUMMARY OF ALL OTHER PROJECTS	1:00	J. COSTELLO
EXTERNAL TANK		
REDESIGNED SOLID ROCKET MOTOR		
SOLID ROCKET BOOSTER		
ORBITER & ORBITER LOGISTICS		
SPACE SHUTTLE MAIN ENGINE		
SPACE SHUTTLE PROGRAM OFFICE		
FLIGHT CREW OPERATIONS OFFICE		
OTHER PROJECTS		
JSC ENGINEERING		
PAYLOAD OPERATIONS		
PROPULSION SYSTEM INTEGRATION		
SPACE & LIFE SCIENCES		
SPECIAL TOPICS	4:30	J. COSTELLO
MARGINAL COST TO ADD OR DELETE ONE FLIGHT		
RECOMMENDATION FOR PRODUCTION/OPERATIONS TRANSFERS		
CONCLUSION	5:00	

ZERO BASE OPERATIONS COST STUDY

COST STUDY STEERING GROUP

JIM COSTELLO	-	COCHAIRMAN
BUCK SIMMS	-	COCHAIRMAN
TOM PERANTIE		
KEN LASSMAN		
SUZAN VOSS		
ROBIN ERSKINE		
ED OLIVER		
RUSS BARDOS		

ZERO BASE OPERATIONS COST STUDY
PROJECT REPRESENTATIVES

ORGANIZATION	REPRESENTATIVE
LAUNCH AND LANDING	ROY THARPE/WAYNE TREAT
LOGISTICS	ROY THARPE/ANNE GAWRONSKI
PAYLOAD PROCESSING	ELLIOT ZIMMERMAN
ENGINEERING	WARREN BRASHER/JON HALL
FLIGHT CREW OPERATIONS	DAVE LEESTMA/CAROL LATTIER
MISSION OPERATIONS	PAUL DELL'OSSO/JACK PETERSEN
ORBITER	RALPH SCHOMBURG
SPACE & LIFE SCIENCES	DON ROBBINS/RALPH ALBON
SSPO	
ENGINEERING INTEGRATION	MAC JONES/JESSE CONTRERAS
INTEGRATION & OPERATIONS	RON LENTZ
MANAGEMENT INTEGRATION	DAVE SCHULTZ
ET	JODY ADAMS
PROPULSION SYSTEMS INTEGRATION	LINDA POSEY
RSRM	SANDY COLEMAN
SRB	JACK HOUSLEY
SSME	MIKE ALLEN

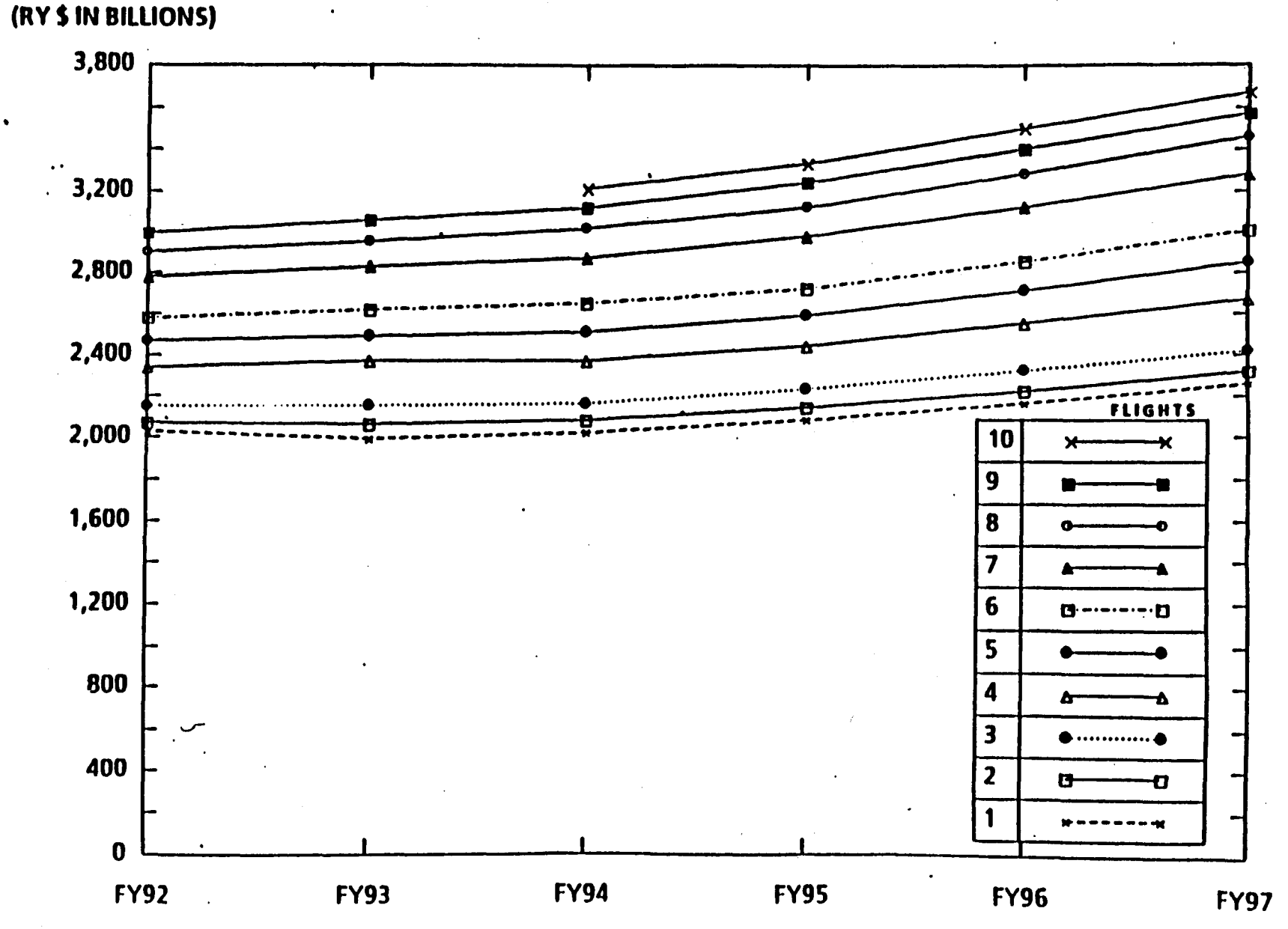
ZERO BASE OPERATIONS COST STUDY

- INITIAL OBJECTIVES DEFINED BY LETTER FROM CAPT. CRIPPEN DATED 1-17-91
  - ESTABLISH THE REQUIREMENTS FOR A MINIMUM FLIGHT RATE CAPABILITY (I.E., WHAT IS REQUIRED TO FLY ONE FLIGHT PER YEAR)
  - IDENTIFY THE INCREMENTAL INCREASES ABOVE THE MINIMUM CAPABILITY TO ACHIEVE THE 10 FLIGHTS PER YEAR MAXIMUM RATE REFLECTED IN THE LATEST MANIFEST
- OBJECTIVES AUGMENTED BY LETTER FROM DR. LENOIR DATED 3-19-91
  - COMPREHENSIVE "BOTTOMS-UP" ASSESSMENT OF COSTS TO OPERATE THE SPACE SHUTTLE
    - ADDRESS ALL ASPECTS OF THE PROGRAM, INCLUDING OPERATIONS, PRODUCTION, AND RELATED CAPABILITY DEVELOPMENT
    - IN SINGLE MISSION INCREMENTS, INDICATE COST TO PLAN AND FLY 1 MISSION PER YEAR UP THROUGH 12 MISSIONS PER YEAR
    - AT EACH STEP, DETERMINE WHAT A 1 TIME ONLY INCREMENT OF 1 FLIGHT WOULD COST; ALSO A 1 TIME DECREMENT OF 1 FLIGHT
  - OSF RESOURCES MANAGEMENT TO CONCUR ON FINAL REPORT OR SUBMIT AN INDEPENDENT REPORT DETAILING AREAS OF NON-CONCURRENCE
  - BRIEFING EARLY JUNE, FINAL REPORT 2 WEEKS LATER

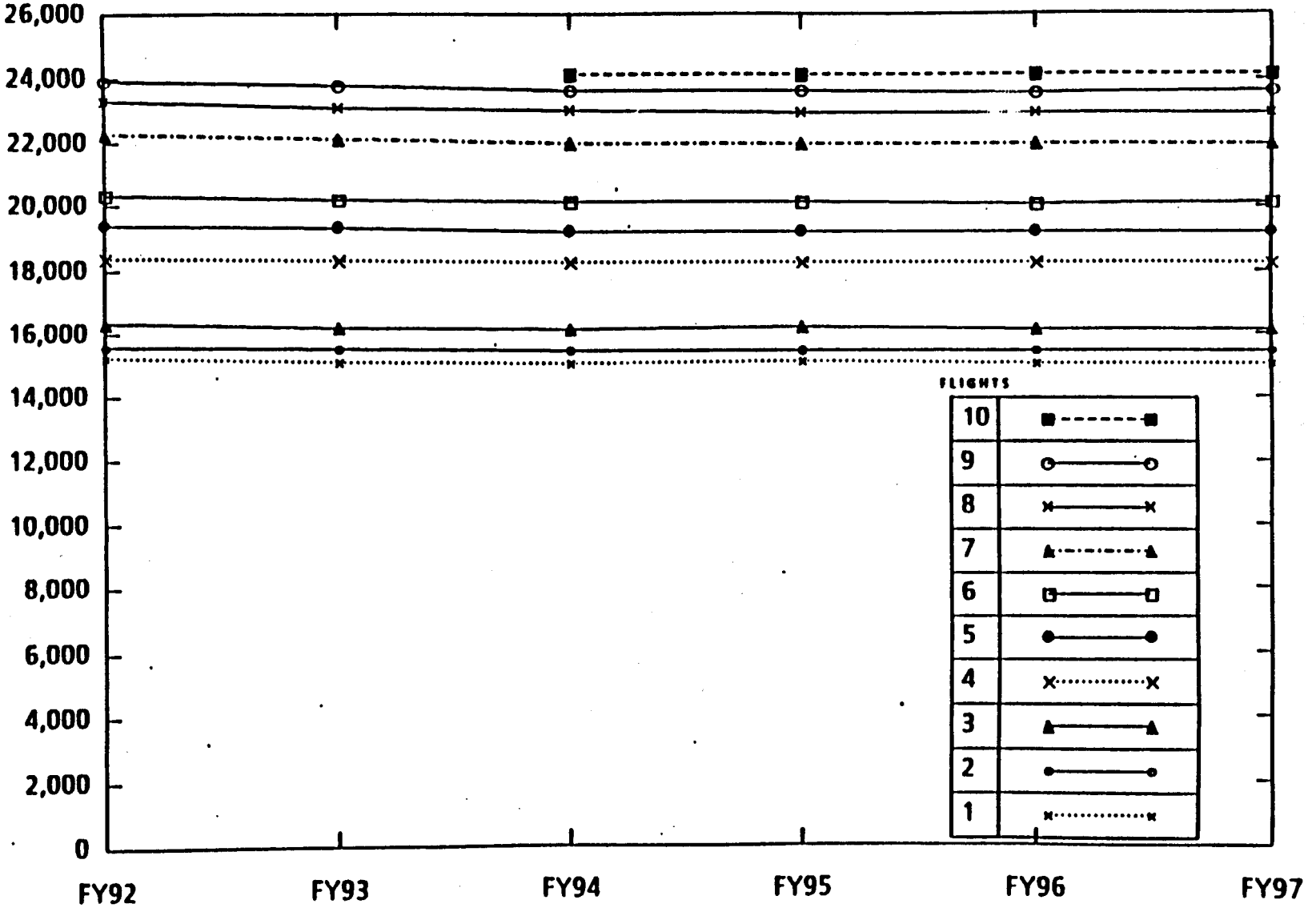
ZERO BASED OPERATIONS COST STUDY
COMMON GROUND RULES AND ASSUMPTIONS

- DID NOT REVIEW IN DETAIL PROJECTS WITH EXPENDITURES BELOW $10M/YEAR. PROJECTS REVIEWED REPRESENT APPROXIMATELY 98% OF TOTAL OPERATIONS COSTS
- THE PROGRAM CONTENT IN THE PRODUCTION BUDGET WILL CONTINUE AT ALL FLIGHT RATES WITH NO CHANGES
- AT LOW FLIGHT RATES WHEN FACILITIES OR VEHICLES ARE NOT NEEDED TO SUPPORT THE FLIGHT RATE, THEY ARE NOT MAINTAINED
- NO COST INCLUDED FOR RETENTION OF CAPABILITY TO INCREASE FLIGHT RATE AT A LATER DATE
- NO OMDP'S PERFORMED ON ORBITER VEHICLES NOT REQUIRED TO MEET THE STEADY STATE FLIGHT RATE
- NO CANNIBALIZATION OF VEHICLES FOR SPARES
- FLIGHTS ARE EVENLY SPACED AT ALL FLIGHT RATES, ESPECIALLY VERY LOW FLIGHT RATES
- FOR 1-6 FLIGHTS PER YEAR, ASSUME 1 OI RELEASE PER YEAR. FOR 7-10, ASSUME AN OI RELEASE EVERY 8 MONTHS (CURRENT RATE).
- MINIMUM BASE FOR ASTRONAUT CORPS IS 40 ASTRONAUTS (20 T-38 PILOTS AND 16 CMDR/PILOT ASSIGNMENTS). MINIMUM BASE SUPPORTS 1-3 FLIGHTS.
- ASSUME ALL SAFETY, DOCUMENTATION, FRR REQUIREMENTS REMAIN "BUSINESS AS USUAL"
- FOR EACH FLIGHT RATE CASE, THAT FLIGHT RATE IS THE ASSUMED STEADY STATE FLIGHT RATE FOR ALL FUTURE YEARS

ZERO BASE OPERATIONS COST STUDY
TOTAL - SPACE SHUTTLE
TOTAL COST SUMMARY



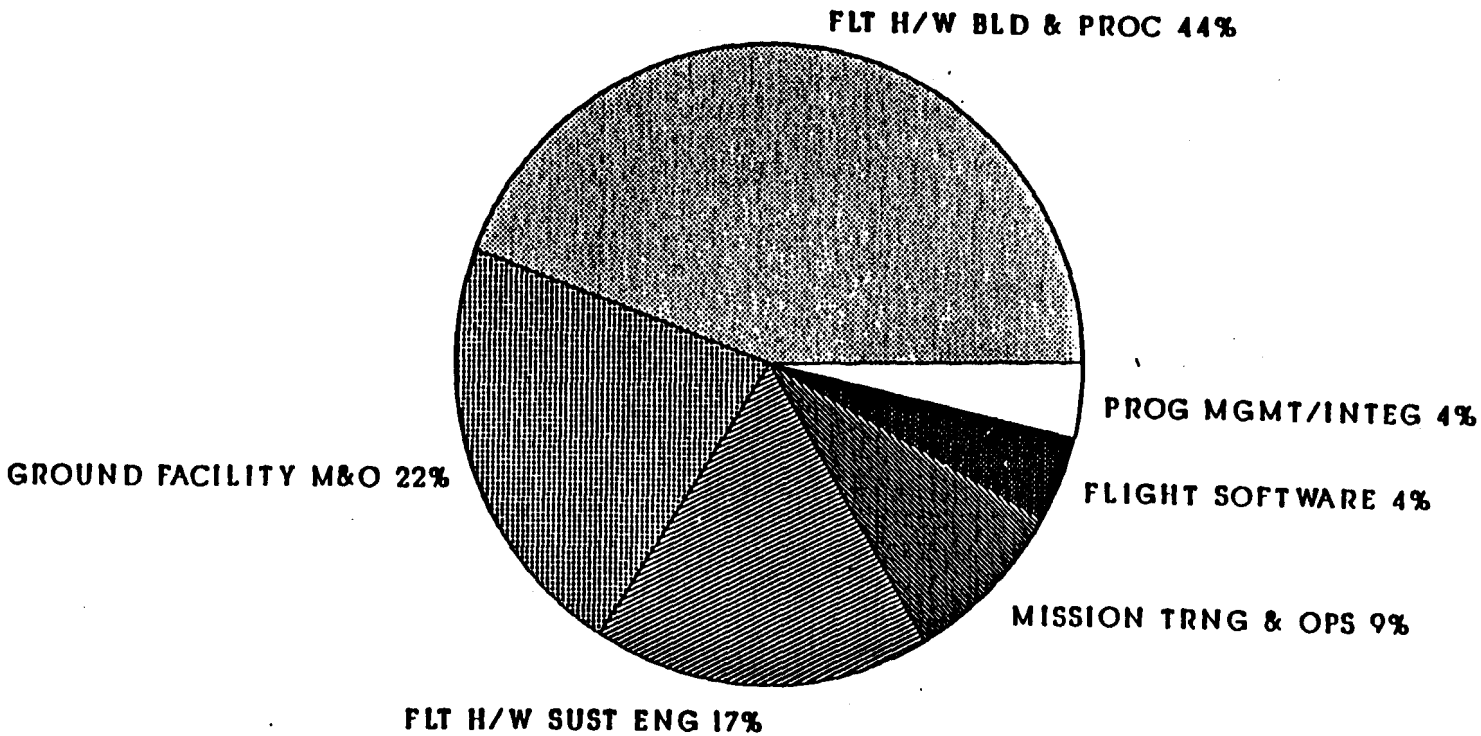
ZERO BASE OPERATIONS COST STUDY
TOTAL - SPACE SHUTTLE
MANPOWER SUMMARY (MYE'S)



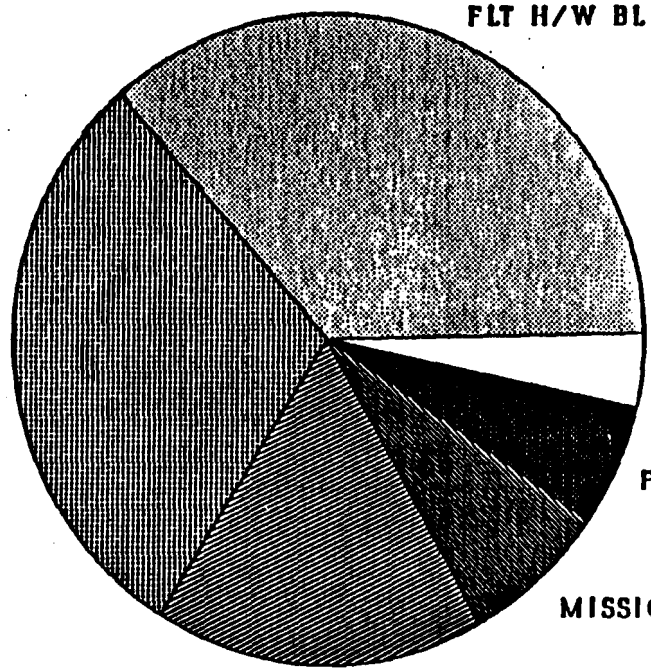
ZERO BASE OPERATIONS COST STUDY
GENERAL CATEGORIES

FLIGHT HARDWARE BUILD & PROCESSING	ET, SRM, SRB - HARDWARE BUILDUP COSTS
	ORBITER AND SSME - LOGISTICS/SPARES, ET DISCONNECTS, FEPC, RMS PROPELLANTS
	LAUNCH PROCESSING AND PAYLOAD PROCESSING
	CREW EQUIPMENT
GROUND FACILITY M&O	SPC M&O - OPF, VAB, LCC, MLP, PAD, ET/SRB STACKING
	STSOC M&O - MCC, SMS, SAIL, FDCF, MAIL
	ET FACILITY M&O - MICHOUD, SLIDELL
	HOSC
	JSC MOCKUPS AND TRAINERS - WETF, P/L MOCKUPS
	JSC MEDICAL LABORATORIES
FLIGHT HARDWARE SUST ENG	FLIGHT SUPPORT ANALYSIS AND ANOMALY RESOLUTION - ALL PROJECTS
	ORBITER SUSTAINING ENGINEERING (EXCEPT FOR BACKUP FLIGHT SOFTW/
	LAUNCH SUPPORT SERVICES - ALL PROJECTS
	JSC ENGINEERING DIRECTORATE (EXCEPT FOR FLIGHT DATA SYSTEMS, I.E. PRIME)
	SHUTTLE PROGRAM OFFICE ENGINEERING INTEGRATION AND PAYLOAD INTEGRATION
MISSION TRAINING & OPERATIONS	DIRECT SUPPORT TO MISSION OPERATIONS DIVISIONS (LOE)
	FCOD - AIRCRAFT M&O, ASTRONAUT SUPPORT
FLIGHT SOFTWARE	IBM PRIME, ORBITER BFS, SDF, SPF
PROGRAM MGMT & INTEGRATION	SSPO MGMT INTEGRATION, MSFC SYSTEMS

ZERO BASE OPERATIONS COST STUDY
ONE FLIGHT BASE COST - FY94



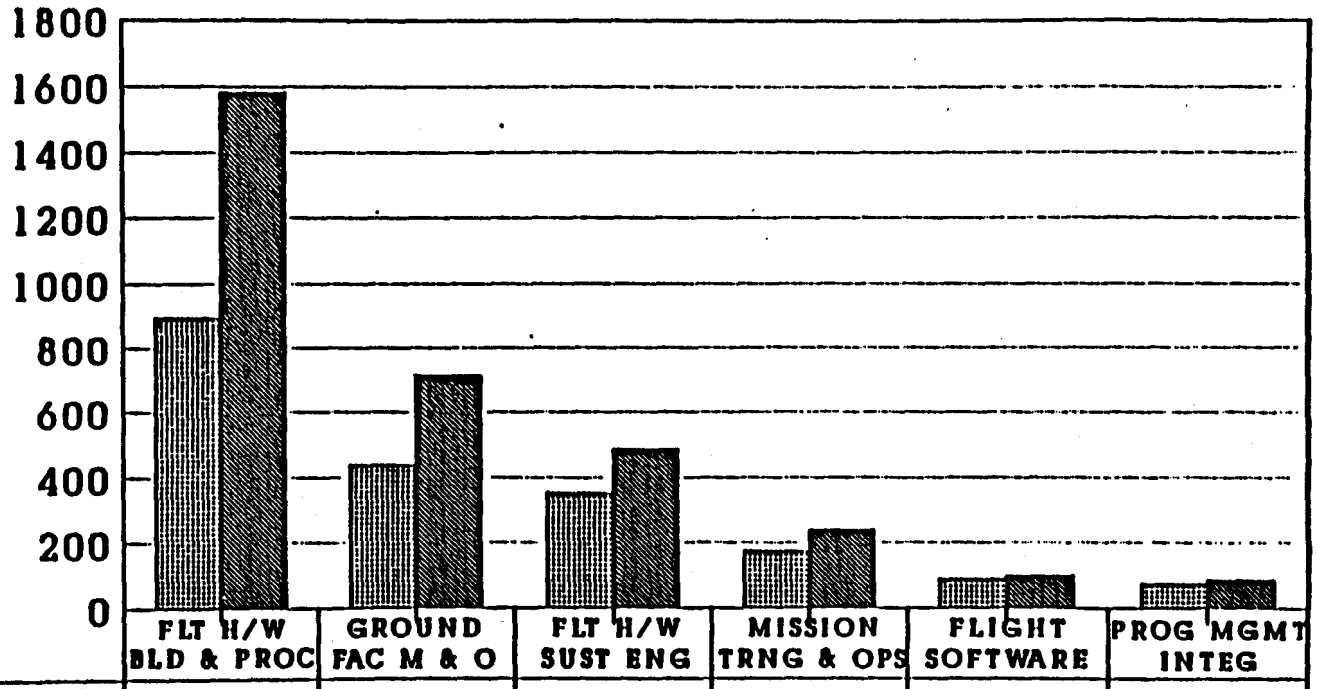
ZERO BASE OPERATIONS COST STUDY
ONE FLIGHT BASE MANPOWER - FY94



MINIMUM BASE IN FY 94

FLT H/W BLD & PROC	5444
GRD FAC M & O	4477
FLT HDW SUST ENG	2536
MISSION OPERATIONS	1118
FLIGHT SOFTWARE	926
PROG MGMT & INTEG	549
SUBTOTAL	16050 EP'S

ZERO BASE OPERATIONS COST STUDY
BASE COST - FY 94



	FLT H/W BLD & PROC	GROUND FAC M & O	FLT H/W SUST ENG	MISSION TRNG & OPS	FLIGHT SOFTWARE	PROG MGMT INTEG
ONE FLIGHT	895	439	351	175	89	75
TEN FLIGHTS	1582	713	486	238	99	87

29-Jun-91

ZERO BASE OPERATIONS COST STUDY
ALL PROJECTS
PERCENT INCREASE OVER BASE -- FY 94 IN RY $

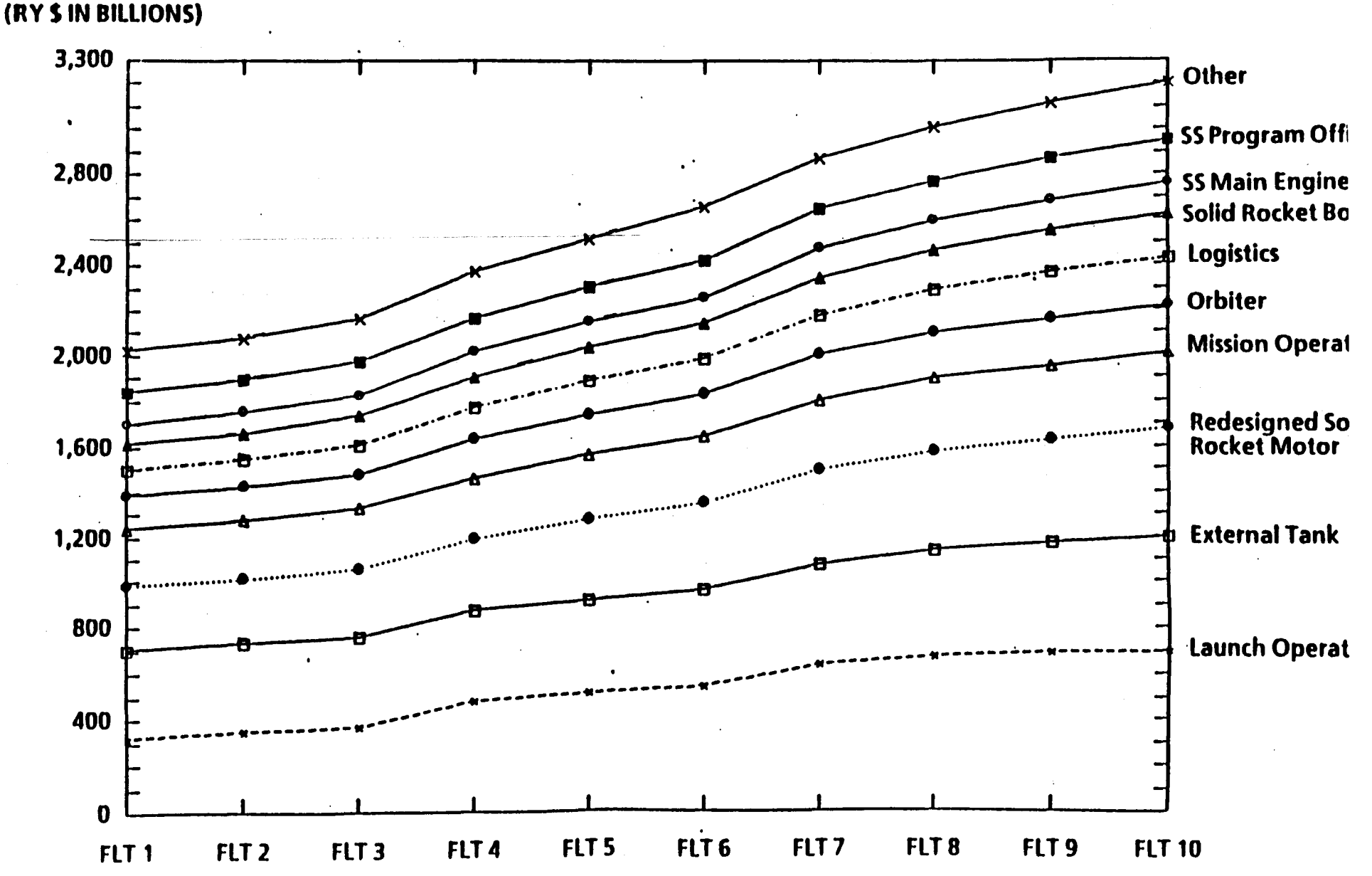
PROJECT	FLIGHT RATE ($)								
	1	2	3	4	5	6	7	8	9
LAUNCH OPERATIONS	100.0	108.0	115.1	150.4	160.7	169.4	199.7	211.8	216.2
EXTERNAL TANK	100.0	100.0	100.0	100.0	104.2	108.6	113.3	118.3	122.6
REDESIGNED SOLID ROCKET MOTOR	100.0	100.0	106.5	113.5	126.1	135.2	146.4	155.5	162.4
MISSION OPERATIONS	100.0	104.1	107.6	110.2	115.4	119.3	125.5	128.7	131.6
ORBITER	100.0	101.9	104.7	116.6	122.7	126.5	136.2	139.0	142.6
SHUTTLE LOGISTICS	100.0	105.4	112.1	119.6	125.4	134.8	148.3	159.2	170.2
SOLID ROCKET BOOSTER	100.0	102.7	111.4	119.5	129.2	135.8	148.1	155.5	165.8
SPACE SHUTTLE MAIN ENGINE	100.0	100.0	100.0	117.2	122.9	128.7	137.7	143.3	151.0
SPACE SHUTTLE PROGRAM OFFICE	100.0	101.2	103.6	107.7	112.8	118.9	123.9	128.7	133.5
OTHER									
- ENGINEERING	100.0	100.4	101.7	104.3	110.0	114.0	115.0	118.5	119.8
- FLIGHT CREW OPERATIONS	100.0	100.0	100.0	112.7	112.7	119.6	121.2	139.6	139.6
- PAYLOAD OPERATIONS	100.0	100.7	177.5	210.6	226.8	269.0	273.9	278.9	297.9
- PROPULSION SYSTEMS INTEGRATION	100.0	103.2	104.8	111.7	111.7	115.3	119.4	119.4	119.4
- SPACE AND LIFE SCIENCES	100.0	110.7	110.7	110.7	110.7	121.4	122.5	122.5	122.5

29-Jun-91

ZERO BASE OPERATIONS COST STUDY
ALL PROJECTS
SHUTTLE OPERATIONS COSTS --- FY 94 IN RY $

PROJECT	FLIGHT RATE ($)									
	1	2	3	4	5	6	7	8	9	1
LAUNCH OPERATIONS	318.9	344.5	367.1	479.6	512.5	540.3	636.8	675.5	689.5	702.
EXTERNAL TANK	389.3	389.3	389.3	389.3	405.5	422.6	441.0	460.6	477.1	493.
REDESIGNED SOLID ROCKET MOTOR	281.2	281.2	299.5	319.1	354.7	380.1	411.7	437.3	456.8	476.
MISSION OPERATIONS	249.1	259.2	268.0	274.4	287.5	297.2	312.5	320.6	327.9	333.
ORBITER	145.2	148.0	152.0	169.3	178.2	183.7	197.7	201.9	207.0	210.
LOGISTICS	119.5	126.0	133.9	142.9	149.9	161.1	177.2	190.2	203.4	209.
SOLID ROCKET BOOSTER	111.0	114.0	123.7	132.6	143.4	150.7	164.4	172.6	184.0	193.
SPACE SHUTTLE MAIN ENGINE	91.6	91.6	91.6	107.4	112.6	117.9	126.1	131.3	138.3	143.
SPACE SHUTTLE PROGRAM OFFICE	140.3	142.0	145.4	151.1	158.2	166.8	173.9	180.6	187.3	193.
OTHER										
- ENGINEERING	76.9	77.2	78.2	80.2	84.6	87.7	88.4	91.1	92.1	92.
- FLIGHT CREW OPERATIONS	43.4	43.4	43.4	48.9	48.9	51.9	52.6	60.6	60.6	60.
- PAYLOAD OPERATIONS	14.2	14.3	25.2	29.9	32.2	38.2	38.9	39.6	42.3	43.
- PROPULSION SYSTEMS INTEGRATION	24.8	25.6	26.0	27.7	27.7	28.6	29.6	29.6	29.6	29.
- SPACE AND LIFE SCIENCES	18.7	20.7	20.7	20.7	20.7	22.7	22.9	22.9	22.9	24.
TOTAL FOR PROJECTS REVIEWED	2024.1	2077.0	2164.0	2373.1	2516.6	2649.5	2873.7	3014.4	3118.8	3205.

SPACE SHUTTLE PROGRAM
ZERO BASE OPERATIONS COST STUDY
SHUTTLE OPERATIONS COSTS -- FY94 IN RY $



EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY

ZERO BASE OPERATIONS COST STUDY
EXTERNAL TANK
GROUNDRULES AND ASSUMPTIONS

- INCREMENTS FOR ANALYSES ARE BASED UPON MINIMUM SKILLS, WORK STATION SHIFTING REQUIREMENTS, AND MAXIMUM FLIGHT RATE
- TOUCH LABOR INCREMENTS BASED UPON MINIMUM SKILL LEVELS AND AVERAGE UNIT VALUES DEVELOPED FROM AN 84% LEARNING CURVE
- ZERO BASE COST INCREMENTS WILL NOT EQUATE TO THE POP 91-1 SUBMI DUE TO COSTS BEING BASED UPON STEADY-STATE CONDITIONS WHICH EXCLUDE BUILDUPS TO SUPPORT RAMP RATE INCREASES, COST REDUCTION INITIATIVES, AND CONSIDERATIONS FOR CURRENT INVENTORIES

ZERO BASE OPERATIONS COST STUDY
EXTERNAL TANK
GROUNDRULES AND ASSUMPTIONS

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27-Jun-91

ZERO BASE OPERATIONS COST STUDY
MSFC – EXTERNAL TANK
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	
ET	BASIC PRODUCTION	249.4	249.4	249.4	249.4	265.4	282.4	300.7	320.2	336.6	352
ET	FLIGHT SUPPORT	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18
ET	LOGISTICS	2.3	2.3	2.3	2.3	2.5	2.6	2.7	2.8	2.9	3
ET	LAUNCH SUPPORT SERVICES	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6
ET	TECHNICAL DIRECTIVES	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9
ET	SLIDELL COMPUTER COMPLEX	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11
ET	TE&A	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6
ET	FACILITIES										
ET	- FACILITIES SELF-SUSTAINING	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49
ET	- PLANT OPERATIONS	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31
ET	- MAF COMMUNICATIONS	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4
	TOTAL	389.3	389.3	389.3	389.3	405.5	422.6	441.0	460.6	477.1	49

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
BASIC PRODUCTION
FY94

	4/YEAR	8/YEAR	10/YEAR
MARTIN MARIETTA LABOR			
TOUCH RELATED (ALL VARIABLE)	$ 45.8M (496EP)	67.6 (746)	80.2 (888)
EQUIV. UNIT RELATED	$ 59.2M (641EP)	72.3 (807)	76.1 (856)
TIME/TASK (ALL FIXED)	$ 64.3M (697EP)	64.3 (697)	64.3 (697)
MATERIAL & SUBCONTRACTS			
VARIABLE	$ 40.9M	73.3	88.1
SEMI-FIXED	$ 11.5M	13.4	13.8
FIXED	$ 20.5M	20.5	20.5
OTHER COSTS	$ 7.2M	8.8	9.6
BASIC PRODUCTION	$ 249.4M	$320.2M	$352.6M

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MANPOWER REQUIREMENTS
(EQUIVALENT)

	BASIC PRODUCTION			FIXED				
	TOUCH RELATED	EQ. UNIT RELATED	TIME/TASK	TECHNICAL DIRECTIVES	FLIGHT SUPPORT	LAUNCH SUPPORT SERVICES	FACILITIES SELF SUSTAINING	TOTAL
ENGINEERING								
@4	44	23	107	15	116	59	---	364
@8	51	36	107	15	116	59	---	384
@10	55	41	107	15	116	59	---	393
TOOLING								
@4	33	78	---	---	---	---	---	111
@8	37	91	---	---	---	---	---	128
@10	39	95	---	---	---	---	---	134
TOUCH								
@4	230	---	---	---	---	---	---	230
@8	404	---	---	---	---	---	---	404
@10	503	---	---	---	---	---	---	503
MGF. SPT.								
@4	106	239	99	29	3	---	4	480
@8	132	317	99	29	3	---	4	584
@10	143	347	99	29	3	---	4	625

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MMC LABOR TASKS

BASIC PRODUCTION - SUPPORT DEPARTMENTS

DEPARTMENT	ESTIMATING BASIS		
	TOUCH RELATED	EQUIVALENT UNITS RELATED	TIME AND TASK RELATED
ENGINEERING	Conceptual Design Dev. Prepare/Maintain System Drawings, Support PDR'S & CDR'S, Contractual Documentation, Compliance with I/F definition	Liason support to Production actions, Support MRB in resolving anomalies, Maintain FMEA/CIL, Maintain acceptance test requirements	Engineering Administration Change processing, Special projects, production improvements, Scheduling and estimating
TOOLING	Design/Fab/Mod Replacement Tools, Tool Maintenance & Repair	Administration/Planning/Scheduling of Tooling Replacement and Tooling Maintenance & Repair, Fabrication dies, jigs, fixtures, and other specialized tools	

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MMC LABOR TASKS

BASIC PRODUCTION - SUPPORT DEPARTMENTS

DEPARTMENT	ESTIMATING BASIS		
	TOUCH RELATED	EQUIVALENT UNITS RELATED	TIME AND TASK RELATED
MANUFACTURING SUPPORT	Supervise and train "Build" employees in Structures, TPS and Final Assy, Supervise and train Production Engineers	Industrial/Production Engineering, Production Control, Work Order Setup, Transportation and Handling, MAR's support, floor support to resolve problems	Estimating Change Control, Industrial Mgmt., Methods and Standards, Production Improvements, Master Plans and Scheduling
INSPECTION	Recurring Inspection of ET Hardware and Tooling Maintenance	Recurring inspection of Tool Maintenance	
QUALITY ASSURANCE SUPPORT	Inspection Supervision, Manufacturing Handling Plan compliance on Critical Hardware moves	Production Floor Quality Compliance, Vendor Surveillance, Process Control Development, Receiving & Shipping, Non-destructive testing and evaluation	Quality Administration, Procedures Development, Records Retention, ADP Development and Support, Production Improvements, Maintain dept. and company procedures

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MANPOWER REQUIREMENTS
(EQUIVALENT)

	BASIC PRODUCTION			FIXED				
	TOUCH RELATED	EQ. UNIT RELATED	TIME/TASK	TECHNICAL DIRECTIVES	FLIGHT SUPPORT	LAUNCH SUPPORT SERVICES	FACILITIES SELF SUSTAINING	TOT
INSPECTION								
@4	60	5	---	---	---	---	---	6
@8	88	6	---	---	---	---	---	9
@10	109	6	---	---	---	---	---	11
QUALITY SUPPORT								
@4	23	149	41	13	19	---	6	25
@8	34	176	41	13	19	---	6	28
@10	39	186	41	13	19	---	6	30
PERF. ENHANCEMENT								
@4	---	---	18	2	---	---	---	2
@8	---	---	18	2	---	---	---	2
@10	---	---	18	2	---	---	---	2
MATERIAL								
@4	---	4	31	---	---	---	1	3
@8	---	8	31	---	---	---	1	4
@10	---	8	31	---	---	---	1	4

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MANPOWER REQUIREMENTS
(EQUIVALENT)

	BASIC PRODUCTION			FIXED				
	TOUCH RELATED	EQ. UNIT RELATED	TIME/TASK	TECHNICAL DIRECTIVES	FLIGHT SUPPORT	LAUNCH SUPPORT SERVICES	FACILITIES SELF SUSTAINING	TOTAL
CONTRACTS								
@4	---	---	20	---	17	---	2	39
@8	---	---	20	---	17	---	2	39
@10	---	---	20	---	17	---	2	39
FINANCE								
@4	---	---	27	---	1	---	1	29
@8	---	---	27	---	1	---	1	29
@10	---	---	27	---	1	---	1	29
PLANNING								
@4	---	---	22	6	4	---	---	32
@8	---	---	22	6	4	---	---	32
@10	---	---	22	6	4	---	---	32
HUMAN RESOURCES								
@4	---	---	17	---	---	---	19	36
@8	---	1	17	---	---	---	19	37
@10	---	1	17	---	---	---	19	37

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MANPOWER REQUIREMENTS
(EQUIVALENT)

	BASIC PRODUCTION			FIXED				
	TOUCH RELATED	EQ. UNIT RELATED	TIME/TASK	TECHNICAL DIRECTIVES	FLIGHT SUPPORT	LAUNCH SUPPORT SERVICES	FACILITIES SELF SUSTAINING	TOT
MIS								
@4	---	---	138	---	17	---	1	15
@8	---	---	138	---	17	---	1	15
@10	---	---	138	---	17	---	1	15
SECURITY								
@4	---	---	---	---	---	---	105	10
@8	---	---	---	---	---	---	105	10
@10	---	---	---	---	---	---	105	10
FACILITIES								
@4	---	143	177	---	---	---	297	61
@8	---	172	177	---	---	---	297	6
@10	---	172	177	---	---	---	297	6
TOTAL								
@4	496	641	697	65	177	59	436	25
@8	746	807	697	65	177	59	436	29
@10	888	856	697	65	177	59	436	31

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MMC LABOR TASKS

BASIC PRODUCTION - SUPPORT DEPARTMENTS

DEPARTMENT	ESTIMATING BASIS		
	TOUCH RELATED	EQUIVALENT UNITS RELATED	TIME AND TASK RELATED
FACILITIES		Facilities Planning, Facilities Administration, Help Desk, Crib (storage), Plant Maintenance, Facilities Operations, Critical Systems Maintenance, Waste Disposal	Environmental Engineering, Equipment Engineering, R&A Craft, R&A Engineering, Maintenance Engineering, General Maintenance, IWTF Maintenance, Computer Support

EXTERNAL TANK
ZERO BASE COST STUDY
BASIC PRODUCTION
MATERIAL AND SUBCONTRACTS - VARIABLE COST

- EACH INCREMENT BASED UPON AN FY91 STEADY STATE ENVIRONMENT
- STEADY STATE ENVIRONMENT IMPLES NO GAPPING TO VENDORS
  - A CONTINUED 4/YR DELIVERY RATE COULD IMPACT EFFICIENCY AT VENDORS IF MSS IS A SIGNIFICANT PERCENT OF SUPPLIER BASE
- THE AVERAGE COST OF A FLIGHT HARDWARE SHIPSET IS $9.3M (BURDENED)

	FY94$ BURDENED TOTAL	AVG.
@ 4/YR	$40.9M	$10.2M
@ 8/YR	$73.3M	$9.2M
@10/YR	$88.1M	$8.8M

- FLIGHT HARDWARE SHIPSET COST IMPROVEMENTS
  - 73% OF THE FLIGHT-BILL-OF-MATERIALS WAS RECOMPETED BETWEEN 4TH AND 5TH BUYS RESULTING IN COST BENEFITS:

	FY91$
4TH BUY	$8.9M
5TH BUY	6.0

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
BASIC PRODUCTION
MATERIAL AND SUBCONTRACTS - SEMI-FIXED

($ IN MILLIONS)*

	FY94		
	@4/YEAR	@8/YEAR	@10/YEAR
• PRODUCTION OPERATIONS			
• TOOLING MAINTENANCE	7.8	8.5	8.6
• TEST PANELS	.1	.3	.5
TOTAL	7.9	8.8	9.1
• FACILITIES			
• MAINTENANCE AND SUPPLIES	2.8	3.2	3.2
• WASTE DISPOSAL	.8	1.4	1.5
TOTAL	3.6	4.6	4.7
• TOTAL	11.5	13.4	13.8

* BURDENED

EXTERNAL TANK
ZERO BASE COST STUDY
BASIC PRODUCTION
MATERIAL & SUBCONTRACTS - FIXED

- ENGINEERING
  - FAILURE ANALYSIS ACTIVITIES IN ENGINEERING LABS
  - SUPPORT QUALIFICATION OF NEW VENDORS
  - PRODUCTION TESTING - TPS SAMPLES
  - SUPPORT SPECIAL ENGINEERING PROJECTS
  - SUPPORT MFG. PROCESS IMPROVEMENTS
- PRODUCTION OPERATIONS
  - SUPPORT MFG. PROCESS IMPROVEMENTS
- PRODUCT ASSURANCE
  - SUBCONTRACT EFFORT FOR VALIDATING MANUFACTURING AND INSPECTION PROCESS
  - WITNESSING FABRICATION
  - CALIBRATION OF TESTING EQUIPMENT
  - QUALITY LAB SUPPLIES
- FACILITIES
  - MANUFACTURING AREA JANITORIAL AND R&A
  - ADPE MAINTENANCE AND SUPPLIES
  - AIR AND GROUNDWATER LAB ANALYSIS
- OTHER
  - SOFTWARE MAINTENANCE AND SUPPLIES
  - PERSONNEL TRAINING AND SUPPLIES

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
BASIC PRODUCTION
MATERIAL & SUBCONTRACTS - FIXED

($ IN MILLIONS)*

	FY94		
	@4/YEAR	@8/YEAR	@10/YEAR
• ENGINEERING	2.7	2.7	2.7
• PRODUCTION	.7	.7	.7
• PRODUCT ASSURANCE	.8	.8	.8
• FACILITIES	16.0	16.0	16.0
• OTHER	.3	.3	.3
TOTAL	20.5	20.5	20.5

* BURDENED

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
FY94

	4/YEAR	8/YEAR	10/YEAR
FLIGHT SUPPORT - FIXED COSTS			
MCC LABOR	$ 18.4M (177EP)	18.4 (177)	18.4 (177)
LOGISTICS			
MATERIAL AND SUBCONTRACTS			
VARIABLE - BARGE MOVEMENT	$ .4M	.9	1.1
FIXED - BARGE OVERHAUL	$ 1.9M	1.9	1.9
TOTAL LOGISTICS	$ 2.3M	2.8	3.0
LAUNCH SUPPORT SERVICES			
MMC LABOR	$ 6.4M (59EP)	6.4 (59)	6.4 (59)
TECHNICAL DIRECTIVES			
MMC LABOR	$ 6.4M (65EP)	6.4 (65)	6.4 (65)
MATERIAL AND SUBCONTRACTORS	$ 3.2M	3.2	3.2
TOTAL TECHNICAL DIRECTIVES	$ 9.6M	9.6	9.6
SLIDELL COMPUTING COMPLEX OPERATIONS	$ 11.2M	11.2	11.2
TE&A (STE, I&PS, RI, SM&QA)	$ 6.5M	6.5	6.5

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
FACILITIES RELATED TASKS
FY94

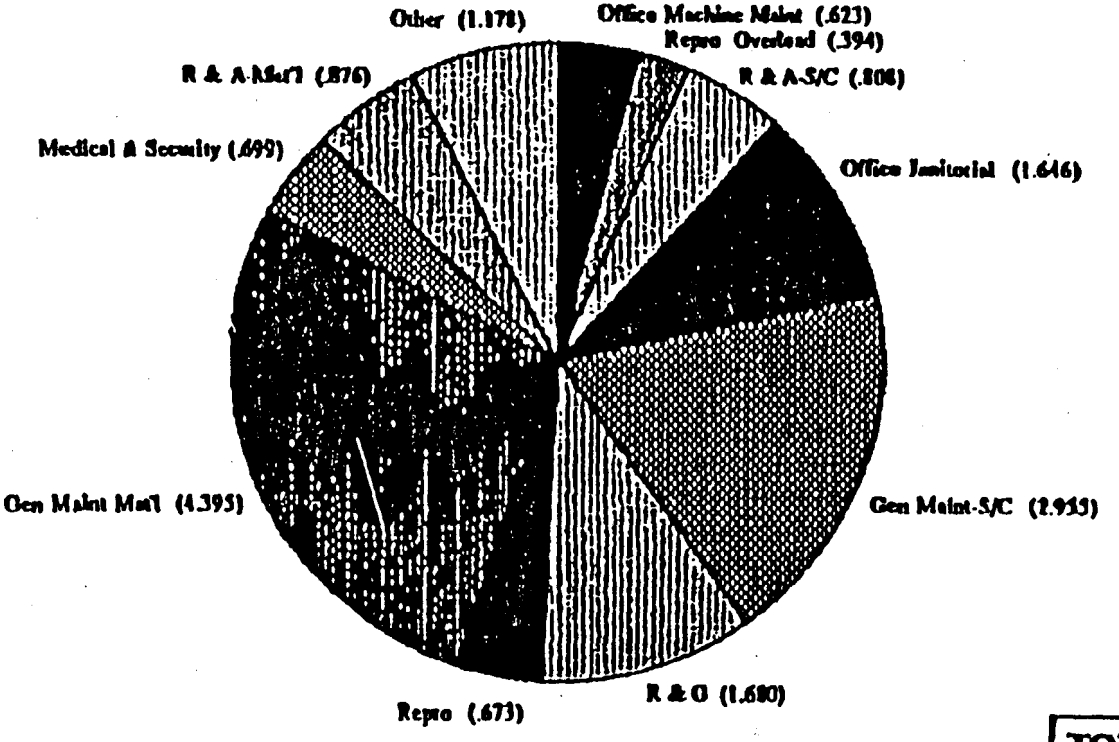
	4/YEAR	8/YEAR	10/YEAR
FACILITIES SELF-SUSTAINING			
MCC LABOR	$ 33.8M (436EP)	33.8 (436)	33.8 (436)
MATERIAL AND SUBCONTRACTS	$ 15.9M	15.9	15.9
TOTAL FACILITIES SELF-SUSTAINING	$ 49.7M	49.7	49.7
PLANT OPERATIONS	$ 31.7M	31.7	31.7
MAF COMMUNICATIONS	$ 4.1M	4.1	4.1
TOTAL FACILITIES RELATED	$ 85.5M	85.5	85.5

EXTERNAL TANK
ZERO BASE OPERATIONS COST STUDY
MANPOWER REQUIREMENTS
(EQUIVALENT)

	BASIC PRODUCTION			FIXED				
	TOUCH RELATED	EQ. UNIT RELATED	TIME/TASK	TECHNICAL DIRECTIVES	FLIGHT SUPPORT	LAUNCH SUPPORT SERVICES	FACILITIES SELF SUSTAINING	TOT
MIS								
@4	---	---	138	---	17	---	1	1
@8	---	---	138	---	17	---	1	1
@10	---	---	138	---	17	---	1	1
SECURITY								
@4	---	---	---	---	---	---	105	1
@8	---	---	---	---	---	---	105	1
@10	---	---	---	---	---	---	105	1
FACILITIES								
@4	---	143	177	---	---	---	297	6
@8	---	172	177	---	---	---	297	6
@10	---	172	177	---	---	---	297	6
TOTAL								
@4	496	641	697	65	177	59	436	25
@8	746	807	697	65	177	59	436	29
@10	888	856	697	65	177	59	436	31

FSS MAT'S AND SUBCONTRACT

FY 94 $ IN MILLIONS ZERO BASE



OTHER	
Asbestos Removal S/C	.111
Chemical Services	.282
Asbestos Removal Mat'l	.121
Office Janitorial	.187
Utility Services & Chemical	.219
Inventory	.241
Inventory Repair	.025
TOTAL OTHER	1.178

TOTAL 15.927

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ZERO BASE OPERATIONS COST STUDY

RSRM PROJECT

ZERO BASE OPERATIONS COST STUDY
MSFC SPACE SHUTTLE
RSRM PROJECT

GENERAL GROUNDRULES/ASSUMPTIONS

- BASIS OF ESTIMATE IS POP 91-1 OPERATIONS DATA BASE
- ASSUMES CONSTANT LAUNCH RATES (2/YR - 10/YR) FOR FY91 - FY97 BUDGET
- SEVERANCE PAY/TRAINING FOR LAYOFFS/RAMP-UPS HAVE NOT BEEN INCLUDED
- THE IMPACT OF RSRME IMPLEMENTATION, QUALIFICATION, AND SAVINGS ARE EXCLUDED
- ASSUMES NO SHUTDOWN OF VENDORS OR FACILITIES
- ASSUMES ONE FSM STATIC TEST PER YEAR
- ASSUMES BUYOUT OF AP SURCHARGE AND AT 6 FLIGHTS PER YEAR, ASSUME ONLY 1 SUPPLIER OF AP REQUIRED
- LABOR RATES AND OVERHEADS WERE ADJUSTED FOR FLIGHT RATE IMPLICATIONS

28-Jun-91

ZERO BASE OPERATIONS COST STUDY
MSFC – REDESIGNED SOLID ROCKET MOTOR
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT		FLIGHT RATE								
			1	2	3	4	5	6	7	8	9
RSRM	MANUFACTURING		94.6	94.6	98.2	102.6	114.9	119.4	124.3	130.3	135.7
RSRM	ENGINEERING/MGMT/OTHER		43.6	43.6	44.1	44.6	47.2	49.1	50.2	52.1	52.1
RSRM	SR&QA		36.7	36.7	38.1	40.6	42.8	46.6	49.9	54.3	54.2
RSRM	AMMONIUM PERCHLORATE		7.7	7.7	11.1	14.2	16.9	19.5	32.2	36.6	41.0
RSRM	OTHER MATERIALS		14.2	14.2	19.5	24.2	31.8	39.3	44.6	48.2	52.9
RSRM	SUBCONTRACTS		7.4	7.4	8.3	9.2	10.8	12.2	13.3	14.8	17.9
RSRM	ODC		11.9	11.9	12.6	13.4	14.9	15.8	17.0	18.2	19.0
RSRM	G&A & FEE		65.1	65.1	67.6	70.3	75.4	78.2	80.2	82.8	84.0
	TOTAL		281.2	281.2	299.5	319.1	354.7	380.1	411.7	437.3	456.8

MSFC
ZERO BASE OPERATIONS COST STUDY
RSRM PROJECT
MAJOR DRIVERS TO THE MINIMUM BASE

FLIGHTS/YEAR	RATIONALE
BASE (2 FLIGHTS)	• MANUFACTURING - ASSUMES PRESENT WORK CENTER STRUCTURE, WORKSTATION CAPACITY, AND SKILL LEVELS REQUIRED TO ACCOMPLISH EACH OPERATION • ENGINEERING/MGMT/OTHER - CRITICAL SKILLS RETENTION • SR&QA - ASSUMES WORK CENTER STRUCTURE AND WORKSTATION CAPACITY • AMMONIUM PERCHLORATE - MINIMUM BUY FROM KERR-MCGEE IS 2 SHIPSETS OF MATERIAL. ASSUME WECCO IS SHUT DOWN. • OTHER MATERIALS AND SUBCONTRACTS - PRICED REQUIRED QUANTITIES, ADJUSTED UP FOR REDUCED QUANTITIES • ODC - INDIVIDUAL ESTIMATES, I.E., LEASES = SAME AS POP 91-1, TRAVEL/ COMPUTER FUNCTION OF MANPOWER • OVERRIDING DRIVERS - 2 PER YEAR BASE PRIMARILY DRIVEN BY CORPORATE RECOMMENDATION. COST EFFECTIVENESS IMPLIES BASE OF APPROXIMATELY 4 FLIGHTS/YEAR.

MSFC

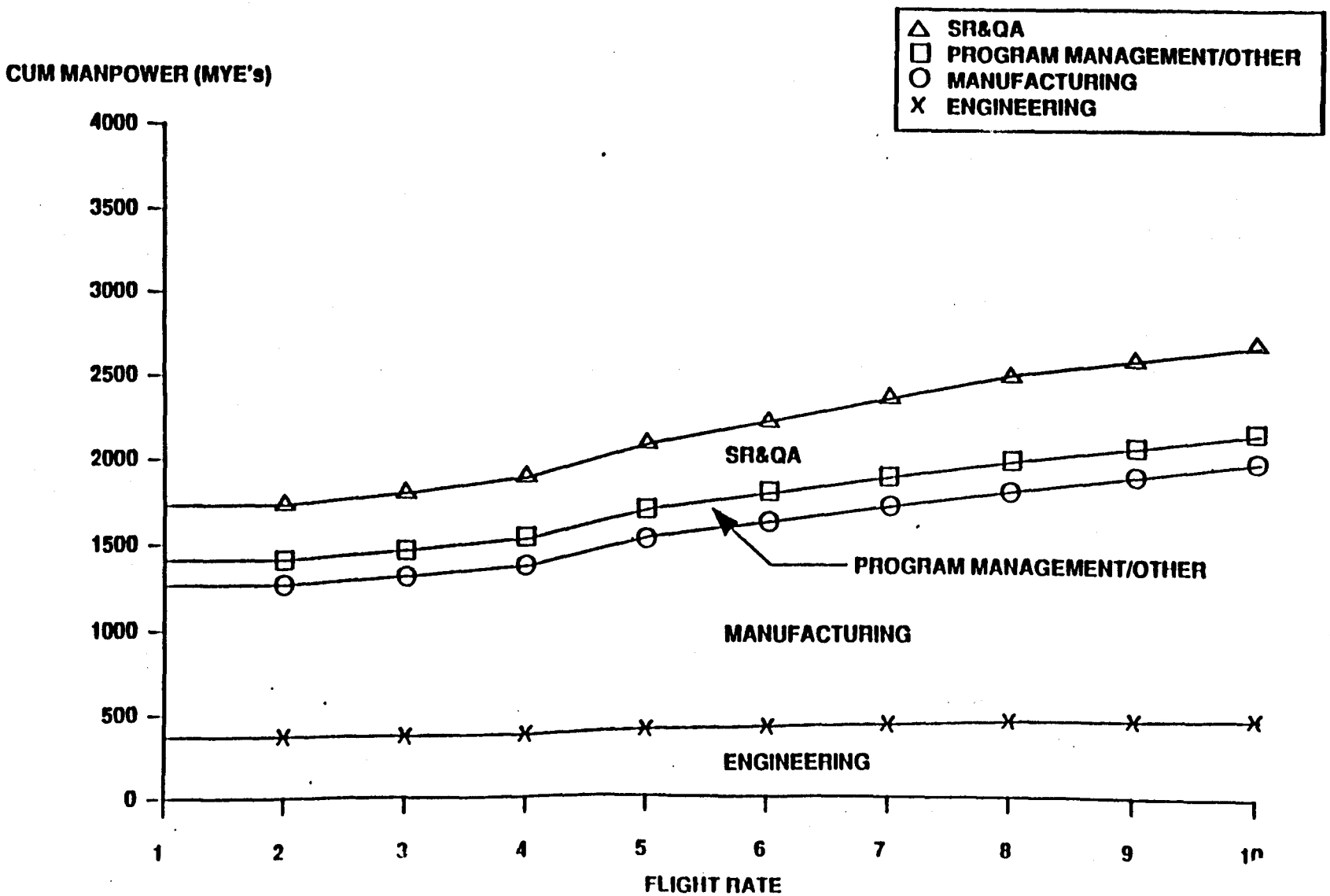
ZERO BASE OPERATIONS COST STUDY
RSRM PROJECT
MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLIGHTS/YEAR	RATIONALE
2 (BASE)	
3	• MANUFACTURING SUPPORT AND TOUCH LABOR; 1 FLT SET MATERIAL
4	• MANUFACTURING SUPPORT AND TOUCH LABOR; 1 FLT SET MATERIAL
5	• MANUFACTURING SUPPORT AND TOUCH LABOR; 1 FLT SET MATERIAL
6	• MANUFACTURING/SR&QA TOUCH LABOR; 1 FLT SET MATERIAL
7	• MANUFACTURING/SR&QA TOUCH LABOR; 1 FLT SET MATERIAL ADD WECCO AS SECOND SOURCE FOR AMMONIUM PERCHLORATE
8	• MANUFACTURING SR&QA TOUCH LABOR; 1 FLT SET MATERIAL
9	• MANUFACTURING TOUCH LABOR; 1 FLT SET MATERIAL
10	• MANUFACTURING TOUCH LABOR; 1 FLT SET MATERIAL

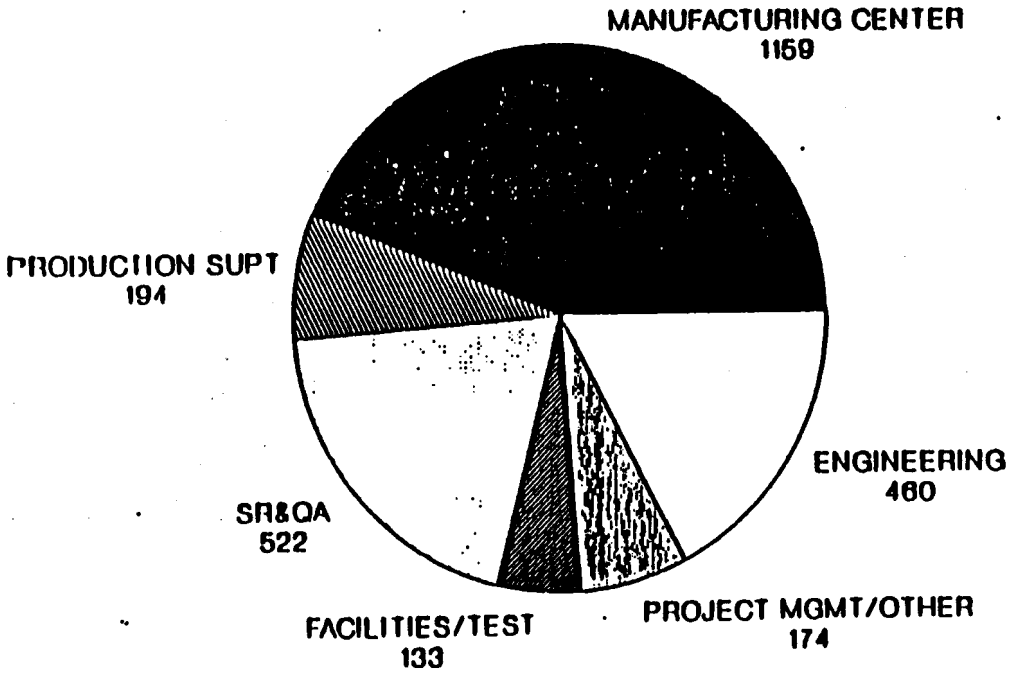
MSFC SPACE SHUTTLE
RSRM PROJECT
ZERO BASE OPERATIONS COST STUDY

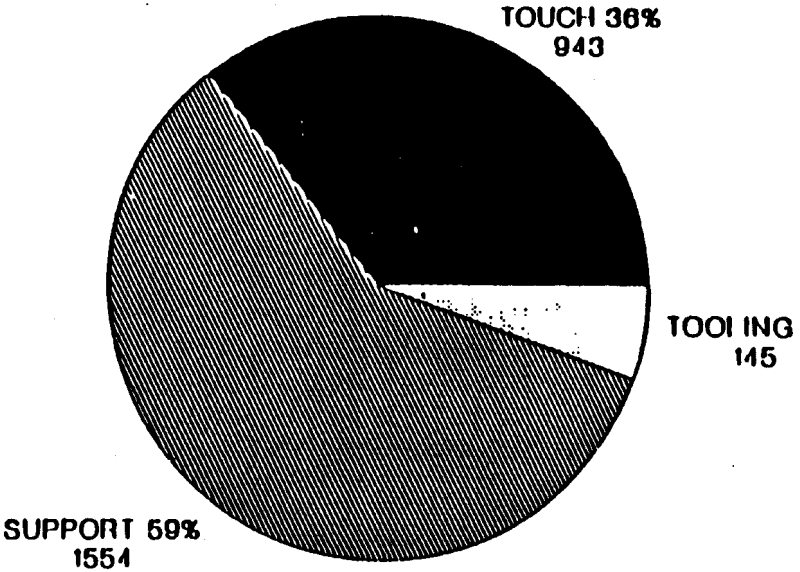
JULY 2, 1991

MANPOWER SUMMARY BY FUNCTION – FY94



RSRM PROGRAM
ZERO BASED OPERATIONS COST STUDY
TOTAL LABOR -- FY94





10 FLIGHTS/YEAR
2642

ZERO BASE OPERATIONS COST STUDY
MSFC SPACE SHUTTLE
RSRM PROJECT
MANUFACTURING AND SR&QA
TOUCH AND SUPPORT MANPOWER - METRICS

TOUCH

- EVALUATED ALL OPERATIONS REQUIRED TO BUILD AND REFURBISH 1 FLIGHT SET OF ALL HARDWARE BASED ON CURRENT RSRM MANUFACTURING STANDARDS AND DEMONSTRATED SRM/RSRM 86% LEARNING CURVE AS INITIAL BASIS OF ESTIMATE
  - ALL DISASSEMBLY AND MANUFACTURING OPERATIONS
  - LOGISTICS AND TRANSPORTATION
  - MANUFACTURING INSPECTION AND RECEIVING INSPECTION
- CONDUCTED A MICRO EVALUATION USING THE FOLLOWING:
  - WORKSTATION CAPACITY
  - MINIMUM NUMBER OF SHIFTS REQUIRED FOR EACH WORKSTATION
  - SKILL LEVEL TO ACCOMPLISH EACH OPERATION
  - MINIMUM NUMBER OF PERSONNEL REQUIRED FOR EACH SKILL LEVEL
  - MINIMUM NUMBER OF HOURS REQUIRED FOR EACH SKILL LEVEL
  - TRANSFER OF SKILLS AS POSSIBLE
  - MINIMUM NUMBER OF PERSONNEL AND UTILIZATION REQUIRED AT LAUNCH RATES 1-4, 6, 8, 10

SUPPORT

- GRASSROOTS ESTIMATE WAS ESTABLISHED FOR EACH WORK CENTER FOR 4 AND 10 LAUNCH RATES

MSFC SPACE SHUTTLE
RSRM PROJECT
ZERO BASE OPERATIONS COST STUDY

ENGINEERING MANPOWER – METRICS

- INITIAL BASIS OF ESTIMATE
  - CURRENT HISTORY
  - HISTORY FACTORED INTO THREE GROUPS
    - FABRICATION SUPPORT
    - FLIGHT SUPPORT
    - FSM STATIC TEST SUPPORT
- ESTIMATE ESTABLISHED BY APPLYING UNIT HISTORY FACTORS TO PROJECT CONTENT
  - ESTIMATE LIMITED BY CRITICAL SKILLS RETENTION REQUIREMENT

ZERO BASE OPERATIONS COST STUDY
MSFC SPACE SHUTTLE
RSRM PROJECT
MATERIALS - METRICS

- PER FLIGHT QUANTITIES BASED ON POP 91-1
- ASSUMES POP 91-1 UNIT COST, ADJUSTED UP FOR REDUCED QUANTITIES; NO VENDORS WERE CONTACTED
- SPECIAL CONSIDERATIONS, MINIMUM REQUIREMENTS
  - RAYON YARN WAS PRICED AT 25,000 POUNDS/WEEK UNTIL MODEL REQUIREMENT MET; THEN VENDOR SHUT DOWN.
  - AMMONIUM PERCHLORATE WAS PRICED WITH KERR MCGEE AS THE SOLE SUPPLIER FROM 2-6 FLIGHTS PER YEAR. AT 7 FLIGHTS PER YEAR, ADEQUATE DEMAND EXISTS TO SUPPORT BOTH KERR MCGEE AND WECCO, AND BOTH SUPPLIERS ARE USED ABOVE THAT RATE.

ZERO BASE OPERATIONS COST STUDY
SRB PROJECT

ZERO BASE OPERATIONS COST STUDY
SRB

APPROACH

- USED POP 91-1 SUBMISSION AS THE BASIS FOR THIS STUDY
- EMPHASIS ON MANPOWER WITH ASSESSMENT AT SKILL LEVEL
- NO SECOND SHIFT OPERATIONS EXCEPT FOR SUPPORT TO SPC & REFURBISHMENT
- SUBCONTRACTS TO BE COMPLETED IN 1992 LEFT IN PLACE
- MAJOR SUBCONTRACTORS PROVIDED INPUT TO EFFECTS OF FLIGHT RATES
- INDIRECT RATES ASSESSED RELATIVE TO CHANGES IN BUSINESS BASE

ZERO BASE OPE[illegible] TIONS COST STUDY
MSFC – SOLID ROCKET BOOSTER
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	
SRB	PRODUCTION OPS	2.5	2.5	2.7	2.9	3.4	3.7	3.9	4.0	4.0	4
SRB	REFURBISHMENT OPS	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1
SRB	PRODUCTION SUPPORT	3.4	3.4	4.1	4.3	4.7	4.9	5.2	5.2	5.2	5
SRB	ENGINEERING	10.1	10.1	10.8	12.5	14.2	15.5	16.5	17.4	17.4	17
SRB	QUALITY	3.1	3.1	3.4	3.4	3.5	3.6	4.4	5.6	5.7	5
SRB	MGMT/OTHER SUPPORT	7.6	7.6	8.5	8.9	9.3	9.6	10.1	10.6	10.6	10
SRB	SUB-CONTRACTS	21.1	22.9	24.2	25.4	27.8	29.3	34.0	36.5	44.8	52
SRB	OTHER DIRECT COSTS	6.2	6.9	8.5	8.7	9.7	10.6	12.5	12.4	13.9	13
SRB	BURDEN	22.9	22.9	24.9	28.0	30.8	32.4	34.8	36.6	36.7	36
SRB	G & A	15.3	15.5	16.2	16.8	17.0	17.2	17.3	17.5	17.5	18
SRB	FEE	12.0	12.3	13.4	14.4	15.6	16.4	18.0	18.9	20.2	21
SRB	PROJECT SUPPORT	5.6	5.6	5.7	5.9	5.9	5.9	6.0	6.1	6.2	6
	TOTAL	111.0	114.0	123.7	132.6	143.4	150.7	164.4	172.6	184.0	19

ZERO BASE OPERATIONS COST STUDY
SRB PROJECT
MAJOR DRIVERS TO THE MINIMUM BASE

FLIGHTS/YEAR	ELEMENT	RATIONALE
1	• ENGINEERING	• CRITICAL SKILLS FOR HUNTSVILLE & FLORIDA OPERATIONS
	• MANAGEMENT/OTHER	• CRITICAL SKILLS
	• PRODUCTION OPERATIONS	• CRITICAL SKILLS FOR TOUCH LABOR AND SUPPORT
	• SR&QA	• CRITICAL SKILLS FOR TOUCH LABOR AND SUPPORT
	• SUBCONTRACTS	• REPHASED BLOCK I PURCHASE WITH PENALTIES FOR: - INCREASE UNIT COST TO REFURBISH/REPAIR FLIGHT HARDWARE AT LOWER FLIGHT RATES - SHELF LIFE DICTATES PHASING PURCHASES ON LESS ECONOMICAL BASIS AT LOWER FLIGHT RATES

ZERO BASE OPERATIONS COST STUDY
DETAILED BASE AND INCREMENT BRIEFING - SRB PROJECT
MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

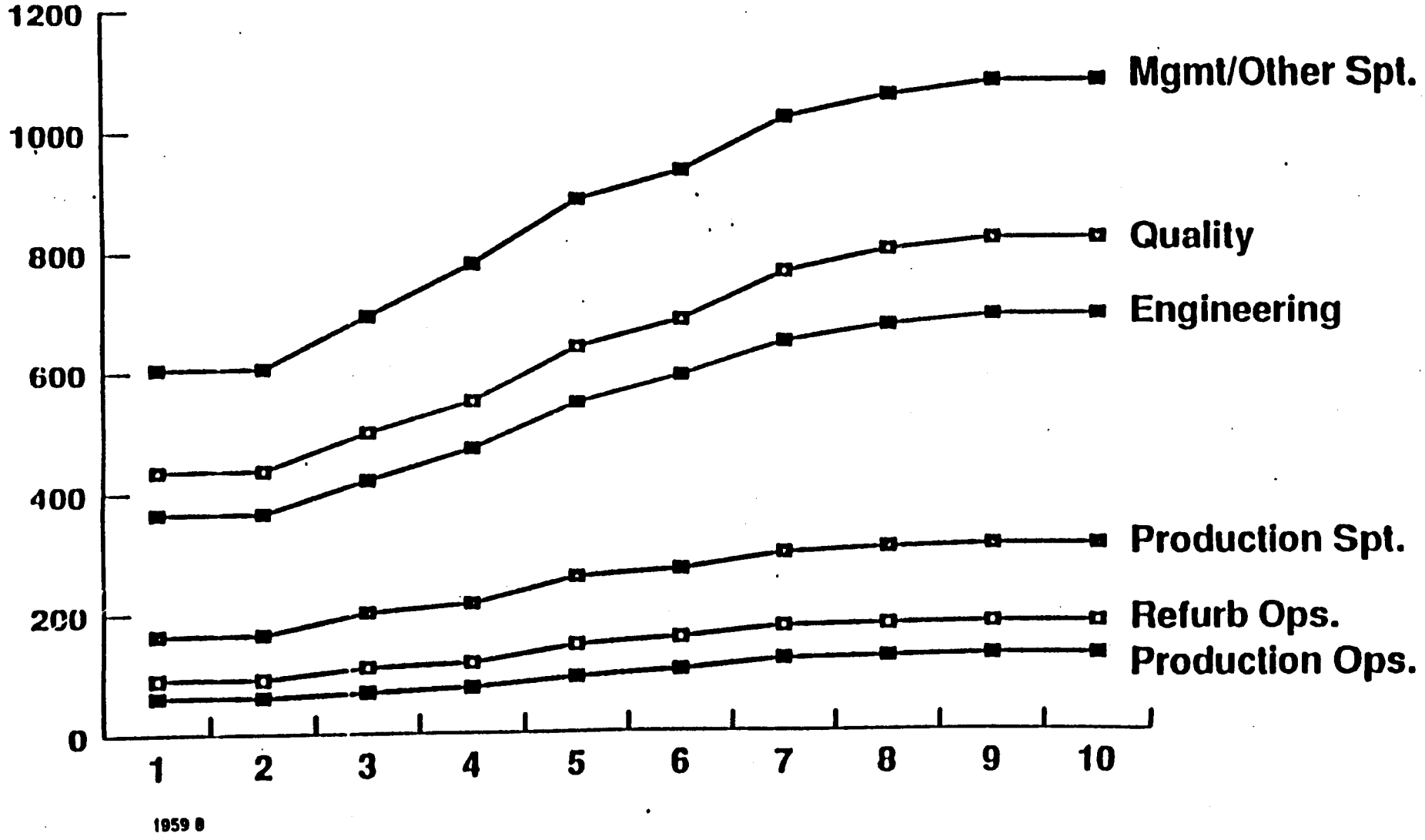
FLIGHTS/YEAR	RATIONALE
1 & 2 (BASE)	ALL MANPOWER ELEMENTS - PROJECT REQUIRES A MINIMUM SKILL LEVEL FC THE CORE STAFF
3	PRODUCTION OPERATIONS - INCREASED HANDS ON LABOR, INSPECTION ANI LOGISTICS
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES
4	ENGINEERING - SEE NOTE BELOW
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES
5	PRODUCTION OPERATIONS - IMPLEMENTED SELECTED SECOND SHIFT OPERATIONS IN REFURBISHMENT DUE TO INCREASED WORKLOAD
	ENGINEERING - SEE NOTE BELOW
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES - BLOCK II BUY BEGINS FY9
6	ENGINEERING - SEE NOTE BELOW
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES - BLOCK II BUY BEGINS FY9
7	ENGINEERING - SEE NOTE BELOW
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES - BLOCK II BUY BEGINS FY9
8-10	PRODUCTION OPERATIONS - IMPLEMENTED SELECTED SECOND SHIFT OPERATIONS IN ASSEMBLY DUE TO INCREASED WORKLOAD
	ENGINEERING - SEE NOTE BELOW
	SUBCONTRACTS - REPHASED BLOCK I PURCHASES - BLOCK II BUY BEGINS FY9 AT 8/YR AND FY93 AT 9&10/YR

NOTE: HUNTSVILLE ENGINEERING
1-2 FLIGHTS: RESOURCE LOADING IS DETERMINED BY "CORE" STAFF REQUIREMENTS
3 FLIGHTS: "METRICS" ADD 27 EP'S OF WORK; 50% OR WORK CAN BE ABSORBED BY "CORE" STAFF. RESOUR(ARE INCREASED BY 14 EP'S.
3-8 FLIGHTS: RESOURCE LOADING FOR EACH FLIGHT REPRESENTS THE ADDITION OF THE 27 EP'S DETERMINED B\ THE METRICS ANALYSIS. MINOR VARIATIONS OCCUR FROM FLIGHT TO FLIGHT DUE TO MINIMUM

ZERO BASE OPERAT)NS COST STUDY

SRB PROJECT

MANPOWER SUMMARY BY FUNCTION (FY94) (MYE'S)

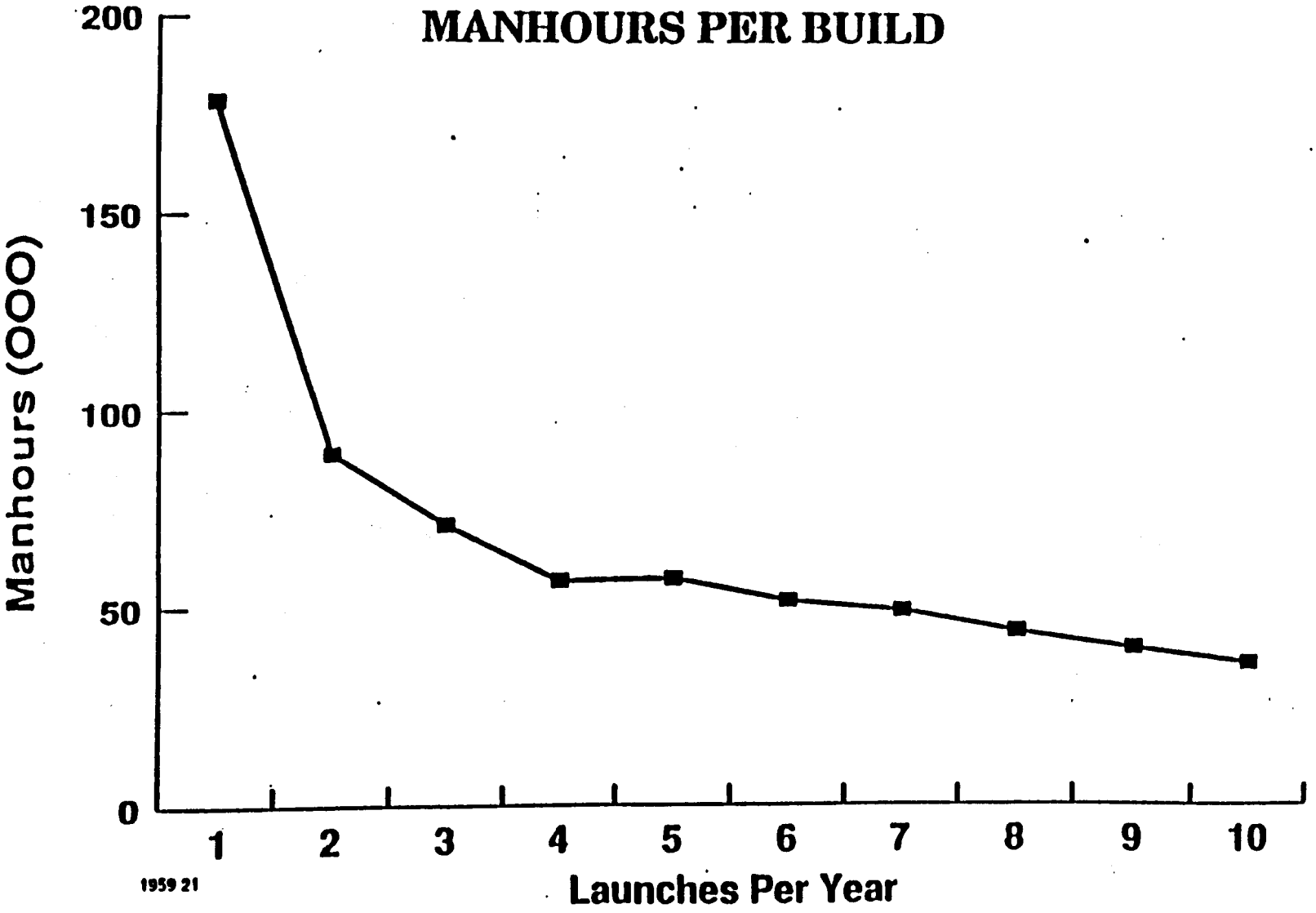


1959-102-17

ZERO BASE OPERAT)NS COST STUDY

SRB PROJECT

PRODUCTION OPERATIONS FY94 TOUCH LABOR - ASSEMBLY & REFURBISHMENT MANHOURS PER BUILD



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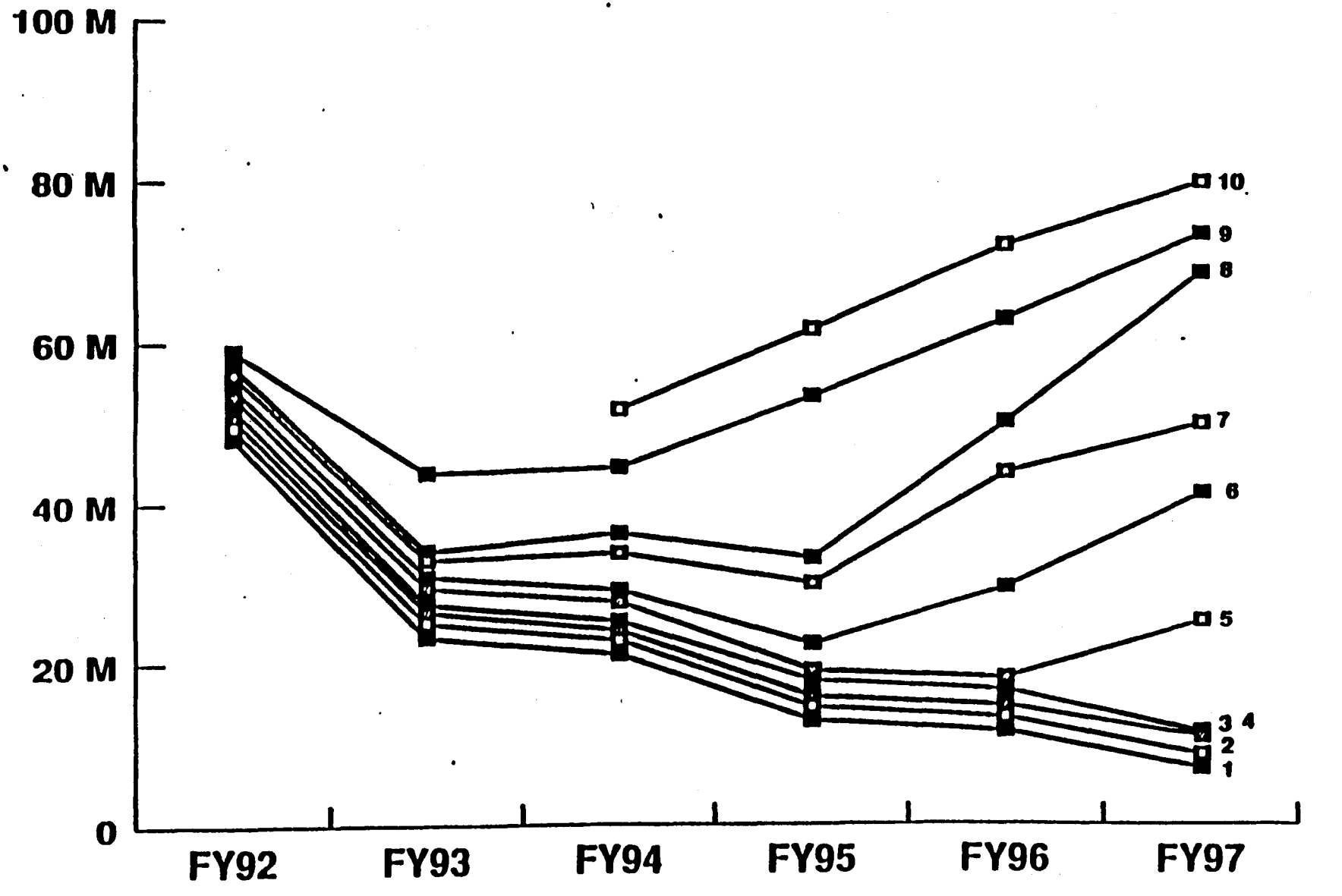
ZERO BASE OPERATIONS COST STUDY
SRB PROJECT
SUBCONTRACT GROUND RULES

- EXISTING PURCHASE ORDERS FOR BLOCK I HARDWARE PROCUREMENTS WERE NOT ADJUSTED, BUT WERE REPHASED FOR LOWER FLIGHT RATES
- SHELF LIFE SENSITIVE HARDWARE (PYROTECHNICS & BATTERIES) WILL REQUIRE ADDITIONAL TESTS/ PROCUREMENTS FOR BLOCK I
- VENDOR FLIGHT HARDWARE REFURBISHMENT COSTS WERE ADJUSTED TO LAUNCH RATES
  - MAJOR VENDORS FOR FLIGHT HARDWARE REFURBISHMENT WERE CONTACTED
- VENDOR SUSTAINING ENGINEERING COSTS WERE ADJUSTED TO LAUNCH RATES
- IDLM COSTS WERE ADJUSTED TO LAUNCH RATES
- PHASE IN FOR BLOCK II REQUIREMENTS WERE ADJUSTED BASED ON LAUNCH RATES

ZERO BASE OPER_ ')NS COST STUDY

SRB PROJECT

SUB-CONTRACTS COST VS FLIGHT RATE (IN MILLIONS)



ZERO BASE OPERA' ONS COST STUDY

SRB PROJECT

SUB-CONTRACTS COST SUMMARY (IN MILLIONS)

Maximum Flight Rate Per Year	*Program Funded Cost (RY $)*					
	FY92	FY93	FY94	FY95	FY96	FY97
1 Block I	48.1	23.2	21.1	12.9	11.6	7.1
2 Block I	49.5	25.0	22.9	14.6	13.3	8.8
3 Block I	50.7	26.4	24.2	15.9	14.8	11.0
4 Block I	51.9	27.4	25.4	17.9	16.7	11.6
5 Block I/Block II	53.4	29.4	27.8	19.1	18.2	14.8/10.6
6 Block I/Block II	54.6	30.9	29.3	20.5/2.0	19.5/10.2	16.8/24.8
7 Block I/Block II	56.1	33.0	31.5/2.5	22.0/8.2	19.4/24.8	18.1/32.3
8 Block I/Block II	57.3	34.1	32.5/4.0	23.1/10.3	21.6/29.0	9.0/60.3
9 Block I/Block II	59.0	37.6/6.3	33.5/11.3	23.8/30.0	12.0/51.5	3.9/70.4
10 Block I/Block II			36.2/15.9	23.9/38.3	11.2/61.7	0/80.8
POP 91-1 Flight Rate	9	9	10	10	10	10

1959-104-48

ORBITER AND GFE PROJECTS
ZERO BASE OPERATIONS COST STUDY
SPACE SHUTTLE PROGRAM

ZERO BASE OPERATIONS COST STUDY

GROUNDRULES AND ASSUMPTIONS

ORBITER - ROCKWELL PRIME

- NEW SOFTWARE OPERATIONAL INCREMENTS @ 1 PER YEAR, BUILDING TO 1 EVERY 8 MONTHS AND COMMENSURATE SAIL AND ISL SUPPORT
- FLIGHT DURATION IS 10 DAYS, INCLUDING AN EVA AND AN RMS DEPLOYED PAYLOAD
- STANDARD MER SUPPORT DURING FLIGHT
- CONFIGURATION CHANGES WILL CONTINUE TO OCCUR
- OMR'S WILL CONTINUE AT CURRENT RATE
- STANDARD COFR REQUIREMENTS, COMMIT-TO-FLIGHT ASSESSMENTS, AND REVIEWS CONTINUE AT CURRENT LEVELS/FLIGHT
- NO MAJOR ANOMALIES OCCUR SUCH AS "BODY FLAP," "HYDROGEN LEAK," ETC.
- VEHICLE LEVEL CERTIFICATION AND VERIFICATION ACTIVITIES RELATED TO FLIGHT ENVELOPE EXPANSION ARE CONSIDERED FIXED COSTS
- SUPPORT REQUIRED BY LOGISTICS FOR HARDWARE REPAIRS, SPARES, F/A ,AND DEPOT CERTIFICATION CONTINUE
- ASSUME SYNERGISTIC BENEFITS WITH OTHER COMPANY EFFORTS EXISTS

ZERO BASE OPERATIONS COST STUDY

GROUNDRULES AND ASSUMPTIONS

FEPC/EMU

- 1 - 3 FLTS/YR - 1 SCHEDULED EVA WITH 3 EMU'S; OTHER FLIGHTS CARRY 2 EMU'S. 1 FLT/YR IS 7-PERSON CREW FLIGHT.
- 4 - 10 FLTS/YR - 1 SCHEDULED EVA FLIGHT PLUS 1 UNSCHEDULED EVA FLIGHT OR HIGH RISK PAYLOAD (E.G., HUBBLE, GRO) REQUIRING THIRD EMU. ALL OTHERS CARRY 2 EMU'S.
- 4 - 10 FLTS/YR - REQUIRES PARALLEL PROCESSING OF SHIPSETS.
- EMU FIELD SUPPORT AVAILABLE FOR 1 - 10 FLTS/YR INCLUDES LIFE SUPPORT AND SUIT TECHNICAL AND LABORATORY PERSONNEL FOR FRR, ANOMALY ANALYSIS AND TEST.
- CREWS NAMED 1 YEAR IN ADVANCE OF FLIGHT.

27-Jun-91

ZERO BASE OPERATIONS COST STUDY
JSC – ORBITER AND GFE PROJECTS
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	10
ORBITER	ORBITER OPS SUPPORT – DOWNEY	86.6	87.7	88.8	96.8	99.1	102.5	104.8	108.2	111.6	113.9
ORBITER	ORBITER LSS – KSC	12.6	13.7	14.5	16.7	18.2	19.7	21.0	21.3	21.5	21.7
ORBITER	ORBITER ET DISCONNECTS	4.4	4.4	5.3	5.3	9.8	9.8	9.8	9.8	10.9	10.9
ORBITER	RMS	7.3	7.8	8.2	8.7	9.1	9.6	10.0	10.5	10.9	11.4
ORBITER	FEPC	22.1	22.1	22.1	28.3	28.3	28.3	36.9	36.9	36.9	36.9
ORBITER	EMU	4.2	4.2	4.2	4.4	4.4	4.4	4.4	4.4	4.4	4.4
ORBITER	JAI DATA SUPPORT	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
ORBITER	IBM DATA PROC SYSTEM	3.3	3.3	4.0	4.0	4.0	4.0	5.4	5.4	5.4	5.4
ORBITER	FLT DATA & EVAL (MER SUPT)	3.4	3.5	3.6	3.8	4.0	4.1	4.1	4.1	4.1	4.1
	TOTAL	145.2	148.0	152.0	169.3	178.2	183.7	197.7	201.9	207.0	210.0

ZERO BASE OPER..IONS COST STUDY
ORBITER & GFE PROJECTS
ELEMENT DESCRIPTIONS

- ORBITER OPERATIONS SUPPORT
  - DOWNEY OPERATIONS - MISSION SUPPORT, PROBLEM RESOLUTION, COMMIT-TO-FLIGHT ANALYSES, HARDWARE CERTIFICATION, BACKUP FLIGHT SOFTWARE (BFS), TURNAROUND SUPPORT, ORBITER PERFORMANCE ENHANCEMENT, PROGRAM MANAGEMENT AND BUDGET CONTROL, CORRECTIVE ACTION REPORT CLOSEOUT, SPECIAL STUDIES
  - HOUSTON OPERATION - TECHNICAL SUPPORT, SHUTTLE AVIONICS INTEGRATION LABORATORY SUPPORT, BFS CERTIFICATION, MISSION SUPPORT, CREW EQUIPMENT SERVICE
- ORBITER LSS - KSC
  - KSC LAUNCH SUPPORT OPERATIONS - FLOW PROCESSING SUPPORT, PROBLEM RESOLUTION, COMMIT-TO-FLIGHT, LAUNCH AND LANDING SUPPORT, CONFIGURATION MANAGEMENT.
- ORBITER/ET DISCONNECTS - FABRICATION OF THE EXTERNAL TANK (ET) SIDE OF THE ORBITER/ET DISCONNECTS FLIGHT HARDWARE
- RMS - REMOTE MANIPULATOR SYSTEM; SUSTAINING ENGINEERING AND REPAIR & OVERHAUL
- FEPC - FLIGHT EQUIPMENT PROCESSING CONTRACT, MANAGEMENT & ADMINISTRATION, ASTRONAUT TRAINING SUPPORT, FLIGHT SUPPORT
- EMU - EXTRAVEHICULAR MOBILITY UNIT - MANAGEMENT & SUSTAINING ENGINEERING, FIELD AND LAB SUPPORT
- JAI DATA SUPPORT - JEFFERSON ASSOC., INC. (JAI) LEVEL OF EFFORT CONTRACT FOR PROGRAM CONTROL DATA SUPPORT
- IBM DATA PROCESSING SYSTEM SUPPORT - SUSTAINING ENGINEERING SUPPORT TO MAINTAIN AND MODIFY THE ORBITER DATA PROCESSING SYSTEM (DPS) HARDWARE LOCATED IN THE JSC GROUND/TRAINING FACILITIES
- FLIGHT DATA AND EVALUATION (MER SUPPORT) - MISSION EVALUATION ROOM (MER) SUPPORT PROVIDES PRE-FLIGHT, REAL TIME, AND POST-FLIGHT ENGINEERING ANALYSIS

ZERO BASE OPERATIONS COST STUDY
ORBITER AND GFE PROJECTS
METRICS

- ORBITER OPERATIONS SUPPORT AND LSS
  - THESE PROGRAMS ARE MADE UP OF A MYRIAD OF TASKS SPREAD ACROSS MULTIPLE DEPARTMENTS AT ROCKWELL DOWNEY AND KSC. EACH TASK THAT IS CONSIDERED FLIGHT RATE DEPENDENT WAS EVALUATED TO DETERMINE THE LEVEL OF EFFORT REQUIRED FOR VARIOUS FLIGHT RATES.
- ET DISCONNECTS
  - BASED ON MARSHALL TANK REQUIREMENTS WITH A MINIMUM PRODUCTION RATE AT THE DISCONNECT SUBCONTRACTOR
- RMS
  - SUSTAINING ENGINEERING - CRITICAL SKILLS PLUS MINIMAL INCREASES (2 EP'S) WITH FLIGHT RATE
  - REPAIR & OVERHAUL - BASE COST TO MAINTAIN REPAIR FACILITY ($2.4M) PLUS HISTORICAL VARIABLE COSTS OF $250K PER FLIGHT
- FEPC/EMU
  - 1 - 3 FLIGHTS - ASSUMES 1 SCHEDULED EVA, WITH 3 EMU'S
  - 4 - 10 FLIGHTS - ASSUMES 1 SCHEDULED EVA PLUS 1 UNSCHEDULED EVA. ALSO REQUIRES PARALLEL PROCESSING OF SHIPSETS
  - BASE COSTS INCLUDE MANAGEMENT, STAFF AND SUPPORT. FLIGHT RATE SENSITIVE COSTS INCLUDE TRAINING AND FLIGHT SUPPORT ACTIVITIES
- JAI DATA SUPPORT
  - IMMUNE TO FLIGHT RATE FLUCTUATIONS. LEVEL OF EFFORT REQUIRED FOR COMPUTER AND ADMINISTRATIVE SUPPORT SERVICES. COST BASED TOTALLY ON EP LEVEL.
- IBM DATA PROCESSING SYSTEM
  - AT A FLIGHT LEVEL OF 1 - 2, THERE IS A MAXIMUM 1 SHIFT OPERATION REQUIRED. ANY GREATER FLIGHT RATE REQUIRES ADDITIONAL SHIFT OPERATIONS. THERE IS A MINIMUM CRITICAL SKILL LEVEL TO OPERATE THE FACILITIES.
- MER
  - A MINIMUM OF 3 MONTHS MUST BE ALLOWED FOR PREPARATION OF THE MER PRIOR TO EACH FLIGHT. GREATER THAN 4 MISSIONS PER YEAR REQUIRES 2 FULL MER SUPPORT TEAMS.
  - THE MER IS STAFFED 24 HOURS A DAY AT L-2 DAYS (TIL LANDING PLUS 1 DAY

KSC SHUTTLE LOGISTICS
ZERO BASE OPERATIONS COST STUDY

ZERO BASE OPERATIONS COST STUDY
KSC SHUTTLE LOGISTICS
GROUNDRULES AND ASSUMPTIONS

- OMDP "ONLY" ON ORBITER IN USE
- NO PLANNED CANNIBALIZATIONS OF UNUSED ORBITERS
- NO EFFORT TO MAINTAIN CAPABILITY TO INCREASE FLIGHT RATE
- NO HEALTH CHECKS ON UNUSED ORBITERS
- ASSUMES "X" NUMBER OF FLIGHTS UNTIL END OF SHUTTLE PROGRAM IN YEAR 2020 FOR PRICING TPS P.U. BUYOUT

27-Jun-91

ZERO BASE OPERATIONS COST STUDY
KSC – SHUTTLE LOGISTICS
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)								
		1	2	3	4	5	6	7	8	9
LOG	SPARES	26.2	27.1	28.1	34.3	35.2	39.2	48.6	54.4	59.6
LOG	REPAIR	60.9	62.9	64.9	68.2	70.3	72.3	75.5	77.4	80.4
LOG	MANPOWER	24.7	25.8	26.6	29.1	29.9	31.4	33.6	34.2	36.2
LOG	TPS	7.7	10.2	14.3	11.3	14.5	18.2	19.7	24.2	27.2
	TOTAL	119.5	126.0	133.9	142.9	149.9	161.1	177.4	190.2	203.4

ZERO BASE OPERATIONS COST STUDY
KSC SHUTTLE LOGISTICS
GROUNDRULES AND ASSUMPTIONS

REPAIR

- VEHICLE REPAIR REQUIREMENTS ARE DRIVEN BY BOTH TIME AND CYCLE PROCESSING ACTIVITIES
- HIGH VALUE SCHEDULED MAINTENANCE
  - HIGH VALUE SCHEDULED MAINTENANCE COSTS (FUEL CELLS, THRUSTERS, OMS ENGINE, ECT.) ARE DRIVEN MAINLY BY THE NUMBER OF FLIGHTS
- PHASE B REPAIR AGREEMENTS
  - SIGNIFICANT REDUCTIONS IN THE CURRENT LEVEL OF REPAIR ACTIVITIES AT THE SUBCONTRACTORS WOULD RESULT IN A LARGE INCREASE IN SKILLS RETENTION (PHASE B) REQUIREMENTS
  - ASSUMED PHASE B REQUIREMENTS WERE 50% OF THE LOST REPAIR COSTS AT LOWER FLIGHT RATES
- PHASE A REPAIR AGREEMENTS
  - PHASE A REPAIR AGREEMENTS WILL BE REQUIRED TO SUSTAIN REPAIR SUBCONTRACTORS REGARDLESS OF FLIGHT RATE
- VENDOR FIELD TRAINING IS A FIXED COST
- TEST EQUIPMENT UPGRADE
  - TEST EQUIPMENT REPLACEMENT/MAINTENANCE REQUIREMENTS ARE DUE TO AGING AND OBSOLESCENCE AND DO NOT VARY WITH FLIGHT RATE
- DEPOT EXTENSION/ENHANCEMENT
  - IMPROVEMENTS TO NSLD CAPABILITIES ARE UNAFFECTED BY FLIGHT RATE CHANGES

ZERO BASE OPERATIONS COST STUDY
KSC SHUTTLE LOGISTICS
GROUNDRULES AND ASSUMPTIONS

SPARES

- CONTRACTS FOR SPARES ALREADY ON ORDER (AUTHORIZED) WILL NOT BE CANCELLED
- CONTRACTS FOR AUTHORIZED SPARES WILL NOT BE MODIFIED TO INTERRUPT THE BUILD CYCLE AND CONTINUE IT AT A LATER DATE
- NOTIFICATION OF FLIGHT RATE CHANGES MUST BE MADE AT A MINIMUM OF LEAD TIME IN ORDER TO MAINTAIN ADEQUATE LEVELS OF SUPPORT-ABILITY. IN GENERAL, LEAD TIMES VARY BETWEEN 6 MONTHS AND 48 MONTHS.
- POS OF 90% WILL BE MAINTAINED AT ALL FLIGHT RATES
- LOW VALUE SPARES REQUIREMENTS ARE BASED ON NUMBER OF VEHICLES IN FLOW, NUMBER OF OPF'S IN SERVICE, AND HISTORY OF DOWNTIME AFTER 51-L
- HIGH VALUE SPARES REQUIREMENTS ARE BASED ON NUMBER OF VEHICLES IN FLOW

ZERO BASE OPERATIONS COST STUDY
KSC SHUTTLE LOGISTICS
GROUNDRULES AND ASSUMPTIONS

TPS

- TPS MANPOWER
  - TPS MANHOUR REQUIREMENTS ARE DRIVEN MAINLY BY OPF OPERATING HOURS
- TPS EQUIPMENT, SPARES AND MAINTENANCE
  - THE ONGOING COSTS ARE REQUIRED FOR SOFTWARE UPGRADES, SERVICE AGREEMENTS, AND MINOR EQUIPMENT PURCHASES. ALSO INCLUDED IS THE MAINTENANCE OF TPSF EQUIPMENT IN AN OPERATIONAL CONDITION
- TPS MATERIAL
  - MINIMUM BASE FOR TPS MATERIALS LIFETIME BUYOUTS IS DEPENDENT ON MINIMUM SKILLS LEVELS FOR THE SUBCONTRACTORS AND THE PERIOD OF TIME NECESSARY TO PRODUCE SUFFICIENT MATERIALS TO THE YEAR 2020 AT THE VARIOUS FLIGHT RATES

ZERO BASE OPERATIONS COST STUDY

KSC SHUTTLE LOGISTICS

MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLIGHTS/YR	HARDWARE REPAIR
1 (BASE)	• FIXED NUMBER OF REPAIR AGENCIES (PHASE A REPAIR AGREEMENTS) • GSE MAINTENANCE REQUIREMENTS ARE NOT DRIVEN BY FLIGHT RATE • MSE MAINTENANCE AT VENDORS IS NOT DRIVEN BY FLIGHT RATE • VENDOR FIELD TRAINING EFFORT IS INDEPENDENT OF FLIGHT RATE • EXTENSION/ENHANCEMENT OF CURRENT DEPOT CAPABILITY WILL OCCUR INDEPENDENT OF FLIGHT RATE • REPAIR TRAFFIC WITH 0 OR 1 FLIGHT IS SIGNIFICANT DUE TO GROUND POWER ON TIME AND ROUTINE OPF PROCESSING/TESTNG • VENDORS REQUIRE SKILLS RETENTION DUE TO COMPLETION OF PRODUCTION BUILD (SPARES/OV-105)
2-10	• REPAIR TRAFFIC INCREASES WITH FLIGHT RATE • SKILLS RETENTION REQUIREMENTS INCREASE AS FLIGHT RATE DECREASES • OVERHAULS FOR FUEL CELLS & OMS ENGINE/THRUST CHAMBERS INCREASE WITH FLIGHT RATE

ZERO BASE OPERATIONS COST STUDY

KSC SHUTTLE LOGISTICS

MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLIGHTS/YR	SPARES
1 (BASE)	• REPLENISHMENT/GSE SPARES REQUIRED TO SUPPORT OPF OPS/TESTING, VEHICLE PROCESSING, AND ONGOING VENDOR REPAIR ACTIVITY • CONDEMNATIONS WILL OCCUR DURING REPAIRS, POWER-UP, OPF OPERATIONS HANDLING OF HARDWARE
2-10	• REPLENISHMENT/GSE SPARES REQMTS INCREASE WITH VEHICLE PROCESSING AND VENDOR REPAIR ACTIVITY • SUSTAINING OPS/CONDEMNATION REQMTS INCREASE WITH FLIGHT RATE • CHANGEOUT SPARES REQMTS FOR OVERHAUL OF FUEL CELLS & OMS ENGINE-THRUSTER CHAMBERS INCREASE WITH FLIGHT RATE

ZERO BASE OPERATIONS COST STUDY

KSC SHUTTLE LOGISTICS

MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLIGHTS/YR	TPS
1 (BASE)	• TPS SPARES & MAINTENANCE REQUIRED TO MAINTAIN EQUIPMENT • MATERIAL QUANTITIES (PU'S) BASED ON MINIMAL SKILLS LEVEL OF CONTRACTOR WORKFORCE • TPS EQUIPMENT PROCUREMENTS REQUIRED FOR SOFTWARE UPGRADES, SERVICE AGREEMENTS, AND MINOR EQUIPMENT PURCHASES • SIGNIFICANT SKILLS MIX IS NECESSARY TO SUPPORT ALL MFG PROCESSES FOR TPSF (LOGISTICS, TRAINING, QA, SHOPS, ENGINEERING, AND COMPUTER SUPPORT
2-10 •	INCREASED REQUIREMENTS FOR SHOP TECHNICIANS & PRODUCTION CONTROL • INCREASED REQUIREMENTS FOR LOGISTICS (SPARES PROCUREMENTS, DISPOSITIONS, ETC.) • INCREASED ENGINEERING SUPPORT FOR MFG & COMPUTER CONTROLLED PROCESSES • INCREASED REQUIREMENTS FOR PROGRAM BUYOUTS OF TPS MATERIALS

ZERO BASE OPERATIONS COST STUDY
LOGISTICS COST SUMMARY ($M)

- THIS COST STUDY ESTIMATES LOGISTICS FUNDING REQUIREMENTS TO SUPPORT SPECIFIC FLIGHT RATES HELD CONSTANT IN ALL YEARS
- APPLICATION OF THIS DATA FOR FLIGHT RATE ADJUSTMENTS WOULD REQUIRE ANALYSIS OF INDIVIDUAL CATEGORIES AND GROUNDRULES/ ASSUMPTIONS ESTABLISHED FOR THOSE INDIVIDUAL CATEGORIES
  - SPARES COMMITMENTS
  - 6-48 MONTH SPARES LEAD TIMES & COST PHASING
  - LEAD TIME TO HIRE AND TRAIN PERSONNEL
  - COST PHASING FOR REPAIR ACTIVITY (48 MONTHS)
  - LOGISTICS REQUIREMENTS FOR SPARES AND REPAIRS ARE MAINLY DRIVEN BY "PROCESSING FLOWS," NOT FLIGHTS
  - A "FLIGHT ATTEMPT" REQUIRES NEARLY THE SAME AMOUNT OF LOGISTICS SUPPORT AS A "PROCESSING FLOW" LESS IN-FLIGHT REQUIREMENTS
  - CANCELLATION OF A FLIGHT DOES NOT NECESSARILY IMPLY 100% CANCELLATION OF A PROCESSING FLOW
- FUNDING REQUIREMENTS DERIVED FROM THIS STUDY EXCEED BUDGET MARKS OF CURRENT FLIGHT MANIFEST

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPACE SHUTTLE PROGRAM

JULY 2, 1991

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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

STUDY PROCESS

- ESTABLISHED GROUNDRULES AND ASSUMPTIONS
- DEVELOPED PROCESSING SCHEDULES
- MANLOADED AT 3 OR 4 LEVEL OF WBS
- SUMMARIZED DATA IN STANDARDIZED FORMATS FOR PRESENTATION

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

LEVEL I/II STEERING GROUP
GROUND RULES & ASSUMPTIONS

- FACILITIES, GSE, & ORBITERS NOT REQUIRED FOR A SPECIFIC FLIGHT RATE - ARE NOT MAINTAINED
- THERE IS NO EFFORT OR COST TO MAINTAIN THE CAPABILITY TO INCREASE LAUNCH RATE
- DO OMDPs ON ORBITERS IN USE
- NO CANNIBALIZATION
- LANDINGS
  - 1 TO 4 FLIGHTS PER YEAR - ALL LANDINGS AT DFRF
  - 5 TO 10 FLIGHTS PER YEAR - 60/40 SPLIT AT DFRF/KSC
- ALL OMRSD REQUIREMENTS ACCOMMODATED

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SHUTTLE PROCESSING TIMELINE

	NO OF SHIFTS	CALENDAR DAYS 5/2	5/3	6/3	7/3
ORBITER/OPF	192	134	90	75	64
OMDP	564	395	263	219	188
ORB VAB	15	11	7	6	5
ORB PAD	72	50	34	28	24
SRB STACKING	72	50	34	28	24
ET C/O	78	54	36	30	26
ET/SRB MATE & C/O	39	27	18	15	13
MLP OPS	219	153	102	85	73

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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

LEVEL I/II STEERING GROUP
GROUND RULES & ASSUMPTIONS

MINIMUM WORK SHIFT ASSUMPTIONS FOR KSC PROCESSING

- ORBITER
  - OPF FLOW 5/2
  - OMDP/STRUCTURAL INSPECTIONS 5/2
- ET
  - STANDALONE CHECKOUT 5/1
- SRB's
  - STANDALONE PROCESSING 5/1
  - STACKING OPERATIONS 5/2
- ET/SRB
  - ET/SRB MATE & CLOSEOUT 5/2
- ORBITER ET/SRB
  - VERTICAL PROCESSING 6/2
  - LAUNCH COUNT 7/3

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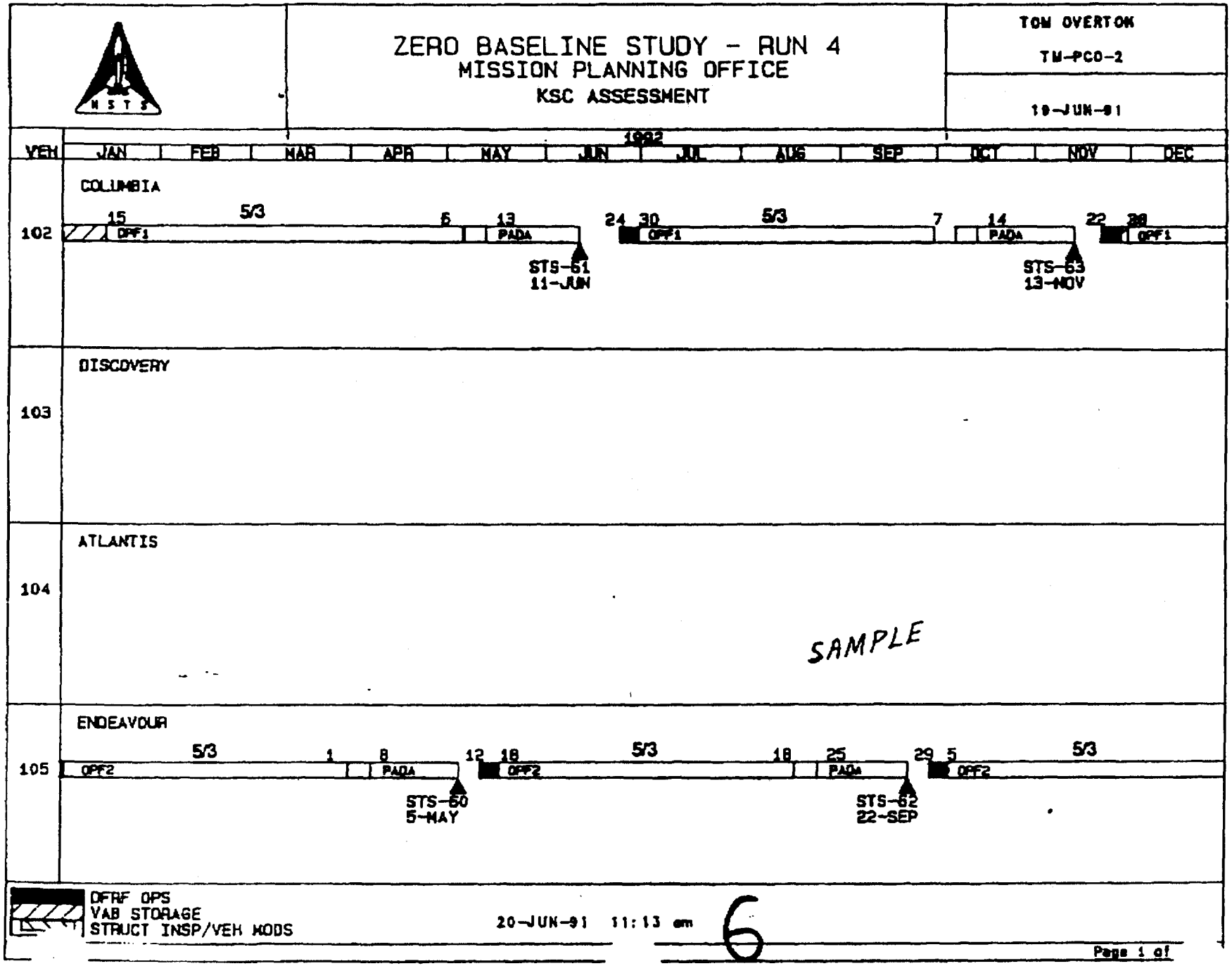

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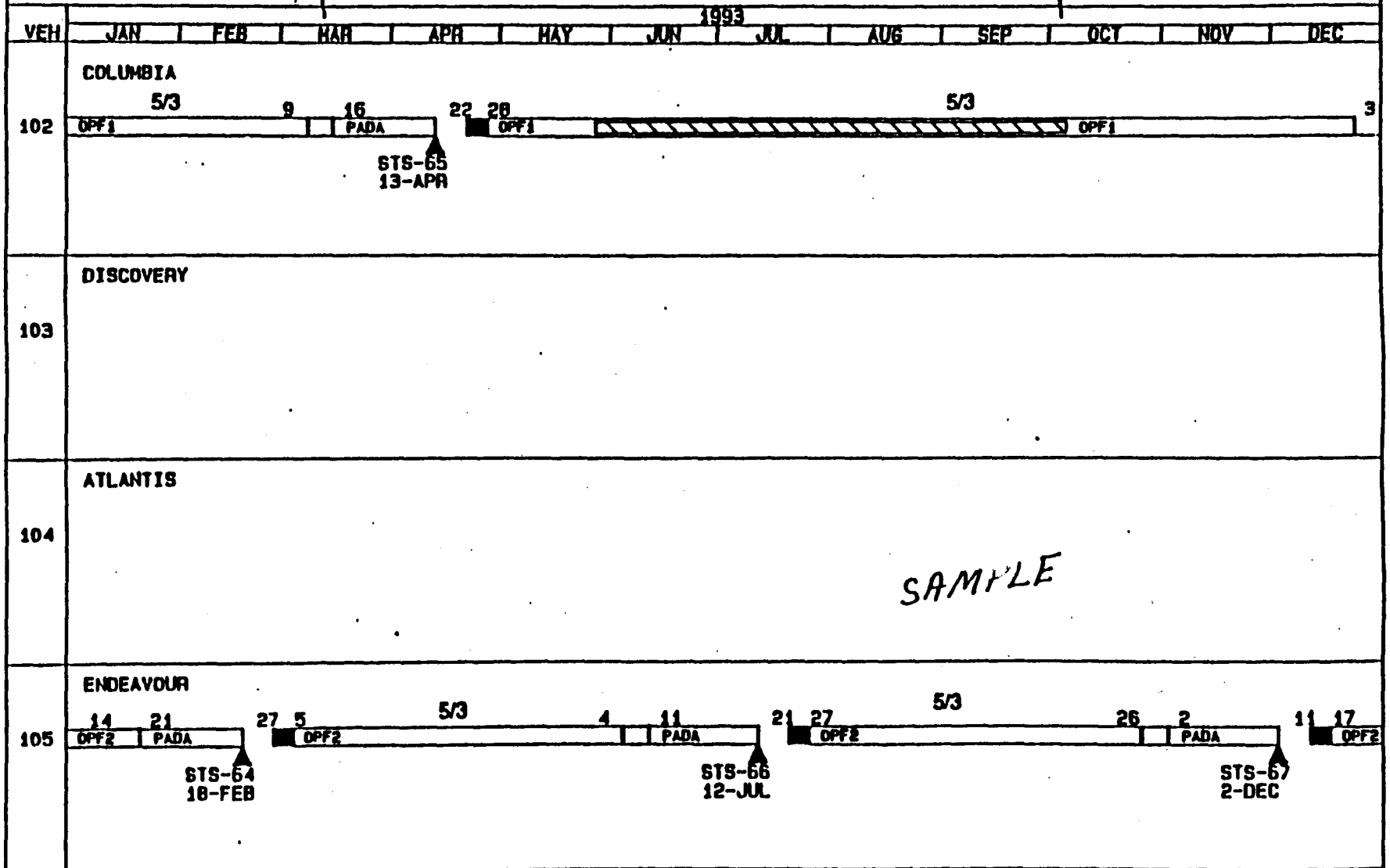
ZERO BASELINE STUDY - RUN 4
MISSION PLANNING OFFICE
KSC ASSESSMENT

TOM OVERTON
TM-PCO-2
19-JUN-91



ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SHIFTING/FACILITY REQUIREMENTS
FLIGHTS PER YEAR

OPERATIONS	1	2	3	4	5	6	7	8	9
ORBITER OPF FLOW	5/2	5/3	7/3	5/3	6/3	7/3	5/3	6/3	6/3
SRB BUILDUP	5/1	5/1	5/1	5/1	5/2	5/2	5/3	5/3	7/3
STACKING & CLOSEOUT	5/2	5/2	5/2	5/2	5/3	5/3	5/3	7/3	7/3
ET CHECKOUT	5/1	5/1	5/1	5/1	5/1	5/2	5/2	5/2	5/2
ET/SRB MATE & C/O	5/2	5/2	5/2	5/2	5/3	5/3	5/3	7/3	7/3
VERTICAL PROCESSING	6/2	6/2	6/3	6/3	6/3	6/3	6/3	6/3	6/3
FACILITIES									
ORBITERS	1	1	1	2	2	2	3	3	4
OPF'S	1	1	1	2	2	2	3	3	3
VAB INTEG CELLS	1	1	1	2	2	2	2	2	2
MLP'S	1	1	1	2	2	2	3	3	3
PAD'S	1	1	1	1	1	1	2	2	2
ET C/O CELLS	1	1	1	1	2	2	2	2	2

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ZERO BASELINE STUDY - RUN 4
MISSION PLANNING OFFICE
KSC ASSESSMENT

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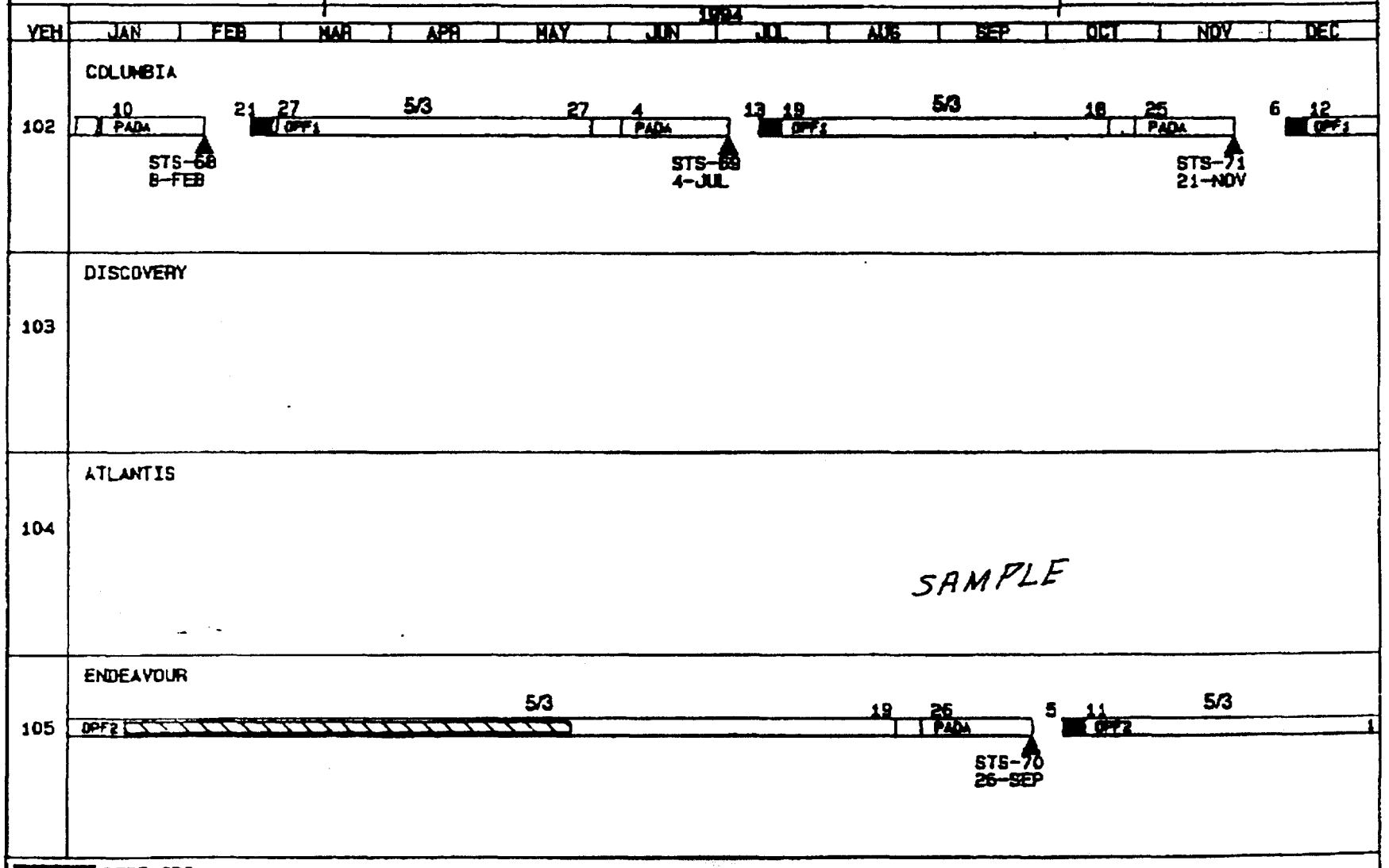


ZERO-BASED MANPOWER-C
3 LAUNCHES (FY:94 $)

WBS	MAJOR TASKS	SUB-TASKS	ORG NUM	FUNCTIONAL ORGANIZATION	LABOR SHIFTS 1st	2nd	3rd	TOTAL HRS	DIR EQ H/C	TOTAL LAB $	NON-LABOR $ * 000 MATL $	SUB-K $	ODC $	TOTAL NL	TOTAL $
1.1	SHUTTLE PROC	1.1.1	1000X	PROG MGR	5,584	0	0	5,584	2.8	179,087					
			1500X	SH/PAYLD INTEG	135,816	0	0	135,816	65.2	4,178,161					
			1600X	INTEGRAT MGT	81,847	4,888	2,870	89,605	47.6	3,044,474					
			1700X	SH/GRD SPT ENG	384,774	7,875	3,887	396,736	191.7	12,261,842					
			2000X	SH PROC OPS	488,255	240,252	46,500	775,008	372.6	23,831,582					
			3000X	SUPPORT OPS	60,037	10,250	2,929	73,216	35.2	2,251,376					
			4000X	LOGISTICS	83,179	8,705	4,836	96,720	46.5	2,974,118					
			5000X	SRM & QA	210,463	80,259	48,735	339,456	163.2	10,438,186					
			8800X	PROGRAM OFFICE	4,368	0	0	4,368	2.1	134,316					
		TOTAL			1,465,803	360,301	101,857	1,927,962	926.9	59,284,080					
		1.1.2	1000X	PROG MGR	1,040	0	0	1,040	0.5	31,980					
			1600X	INTEGRAT MGT	16,994	884	0	17,888	8.6	550,052					
			1700X	SH/GRD SPT ENG	61,867	1,365	0	63,232	30.4	1,944,378					
			2100X	PROC OPS CONTL	3,713	655	0	4,368	2.1	134,316					
			2300X	OPF OPS	1,172	650	0	1,872	0.9	57,564					
			3300X	FACILITY O&M	27,315	13,453	0	40,768	19.6	1,253,607					
			4000X	LOGISTICS	16,657	1,647	0	18,304	8.8	562,844					
			8000X	ET/SRB OPS	1,040	0	0	1,040	0.5	31,980					
			8100X	VAB OPS (THI)	242,386	53,202	0	295,588	142.1	9,089,046					
		TOTAL			372,270	71,810	0	444,080	213.5	13,655,380					
		1.1.3	1600X	INTEGRAT MGT	11,856	0	0	11,856	5.7	364,569					
			1700X	SH/GRD SPT ENG	50,336	0	0	50,336	24.2	1,547,821					
			2000X	SH PROC OPS	3,120	0	0	3,120	1.5	95,939					
			3300X	FACILITY O&M	5,824	0	0	5,824	2.8	179,087					
			4000X	LOGISTICS	624	0	0	624	0.3	19,188					
			8000X	ET/SRB OPS	1,248	0	0	1,248	0.6	38,376					
			8100X	VAB OPS (THI)	117,728	0	0	117,728	56.6	3,620,110					
		TOTAL			190,736	0	0	190,736	91.7	5,865,080					
		1.1.4	1100X	SH DATA SYSTEM	0	0	0	0	0.0	0					
			1600X	INTEGRAT MGT	51,467	2,808	1,885	56,160	27.0	1,726,907					
			1700X	SH/GRD SPT ENG	88,573	1,826	913	91,312	43.9	2,807,823					
			2000X	SH PROC OPS	113,481	55,840	10,805	180,126	86.6	5,538,885					
			3000X	SUPPORT OPS	43,152	7,367	2,105	52,624	25.3	1,618,176					
			4000X	LOGISTICS	23,781	2,490	1,393	27,664	13.3	850,652					
			5000X	SRM & QA	15,462	6,052	3,070	25,584	12.3	786,702					
			6000X	ET/SRB OPS	0	0	0	0	0.0	0					
			8100X	VAB OPS (THI)	31,279	11,569	0	42,848	20.6	1,317,566					
		TOTAL			357,804	98,552	19,964	476,320	229.0	14,646,730					
TOTAL SHUTTLE PROC					2,386,414	520,753	121,821	3,039,084	1,461	93,451,272	408,408.0	6,291,121.2	2,101,335.6	8,800,864.8	102,252,137

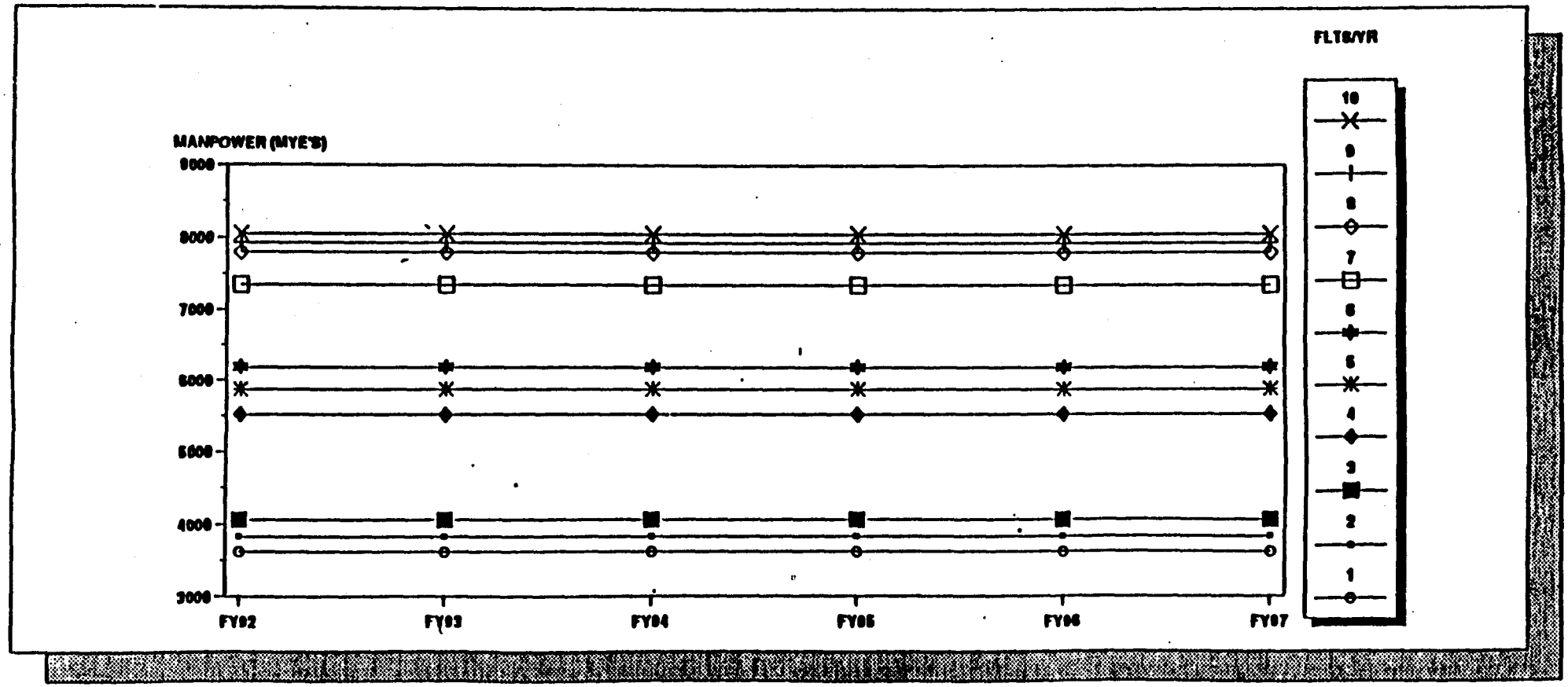
SAMPLE

COMPTROLLER/KSC

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

MANPOWER SUMMARY



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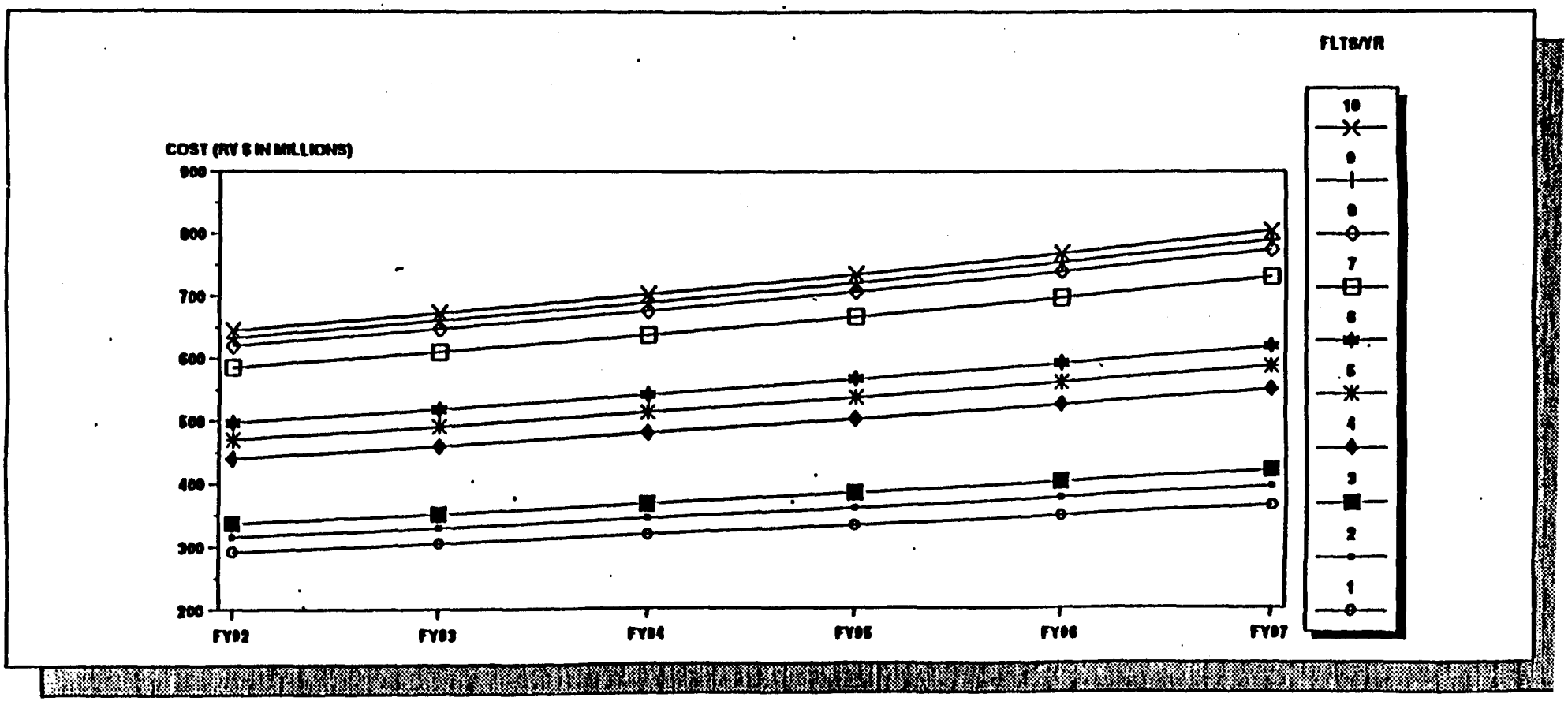
ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

TOTAL COST VS. FLIGHT RATE



NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

MANPOWER SUMMARY

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	3,616	3,616	3,616	3,616	3,616	3,616
2	3,831	3,831	3,831	3,831	3,831	3,831
3	4,057	4,057	4,057	4,057	4,057	4,057
4	5,511	5,511	5,511	5,511	5,511	5,511
5	5,868	5,868	5,868	5,868	5,868	5,868
6	6,178	6,178	6,178	6,178	6,178	6,178
7	7,344	7,344	7,344	7,344	7,344	7,344
8	7,795	7,795	7,795	7,795	7,795	7,795
9	7,926	7,926	7,926	7,926	7,926	7,926
10	8,051	8,051	8,051	8,051	8,051	8,051
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

TOTAL COST SUMMARY
($ IN MILLIONS)

MAXIMUM FLIGHT RATE PER YEAR	PROGRAM FUNDED COST (RY $)					
	FY92	FY93	FY94	FY95	FY96	FY97
1	292.1	305.0	318.9	333.0	348.0	363.7
2	315.7	329.5	344.5	360.0	376.2	393.1
3	336.5	351.1	367.1	383.6	400.9	418.9
4	439.5	458.8	479.6	501.2	523.7	547.3
5	469.6	490.2	512.5	535.5	559.6	584.8
6	496.3	517.4	540.3	564.9	590.3	616.3
7	584.9	609.9	636.8	665.7	695.8	728.3
8	620.2	646.9	675.5	706.1	738.0	772.4
9	633.0	660.3	689.5	720.5	753.3	788.4
10	644.7	672.6	702.4	733.7	767.4	803.1
POP 91-1 FLIGHT RATE	9	9	10	10	10	10
POP 91-1 GUIDELINES	633.9	649.1	700.3	735.2	766.7	

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SHUTTLE OPERATIONS MANPOWER BY ELEMENT

ELEMENT	1	2	3	4	5	6	7	8	9	10
1.1 SHUTTLE PROC	1,262	1,364	1,461	2,187	2,348	2,495	2,856	3,141	3,208	3,333
1.2 SYSTEMS ENG/SPT	59	59	59	85	85	85	118	118	151	151
1.3 FACILITY O & M	769	769	769	1,044	1,089	1,089	1,468	1,468	1,483	1,483
1.4 LPS/INSTRU & CAL	408	408	408	588	588	588	768	768	768	768
1.5 OPS MODS	66	66	66	81	81	81	96	96	96	96
1.6 TECHNICAL OPS SPT	442	508	585	672	773	889	1,022	1,175	1,188	1,188
1.7 PROGRAM OPS SPT	211	252	293	334	375	415	423	430	433	433
1.9 COMMUNICATIONS	188	188	188	275	275	275	326	326	326	326
1.14.2 SPECIAL PROJ	3	3	3	3	3	3	3	3	3	3
BOC	190	195	205	221	229	236	242	247	247	247
LSS	18	19	20	21	22	22	22	22	22	22
PROP	0	0	0	0	0	0	0	0	0	0
94 TOTAL	3,616	3,831	4,057	5,511	5,868	6,178	7,344	7,795	7,926	8,051

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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **SHUTTLE PROCESSING (WBS 1.1)** -- Work associated with on-line operations required to process the Orbiter, Payload, External Tank (ET), Solid Rocket Boosters (SRB), and mission equipment through pre-launch, launch, post-launch, landing, and SRB retrieval activities.
  - Orbiter Operations (WBS 1.1.1) -- All tasks performed on the stand-alone Orbiter including routine maintenance, non-routine work associated with Problem Reporting and Corrective Action (PRACA), modifications, tile maintenance and modifications, and landing operations at primary/contingency landing sites.
  - Solid Rocket Booster (SRB) Operations (WBS 1.1.2) -- All tasks performed on the stand-alone SRB, including processing and modifications, stacking operations, preparation for mate to the ET, and retrieval and disassembly operations.
  - External Tank (ET) Operations (WBS 1.1.3) -- All tasks performed on the stand-alone ET, including receiving, processing the ET through the VAB ET checkout cell, modifications, and preparation for SRB/ET mate.
  - Launch Operations (WBS 1.1.4) -- All tasks required to mate the flight elements and process the integrated vehicle, including pre-launch servicing, integrated testing, and launch countdown.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

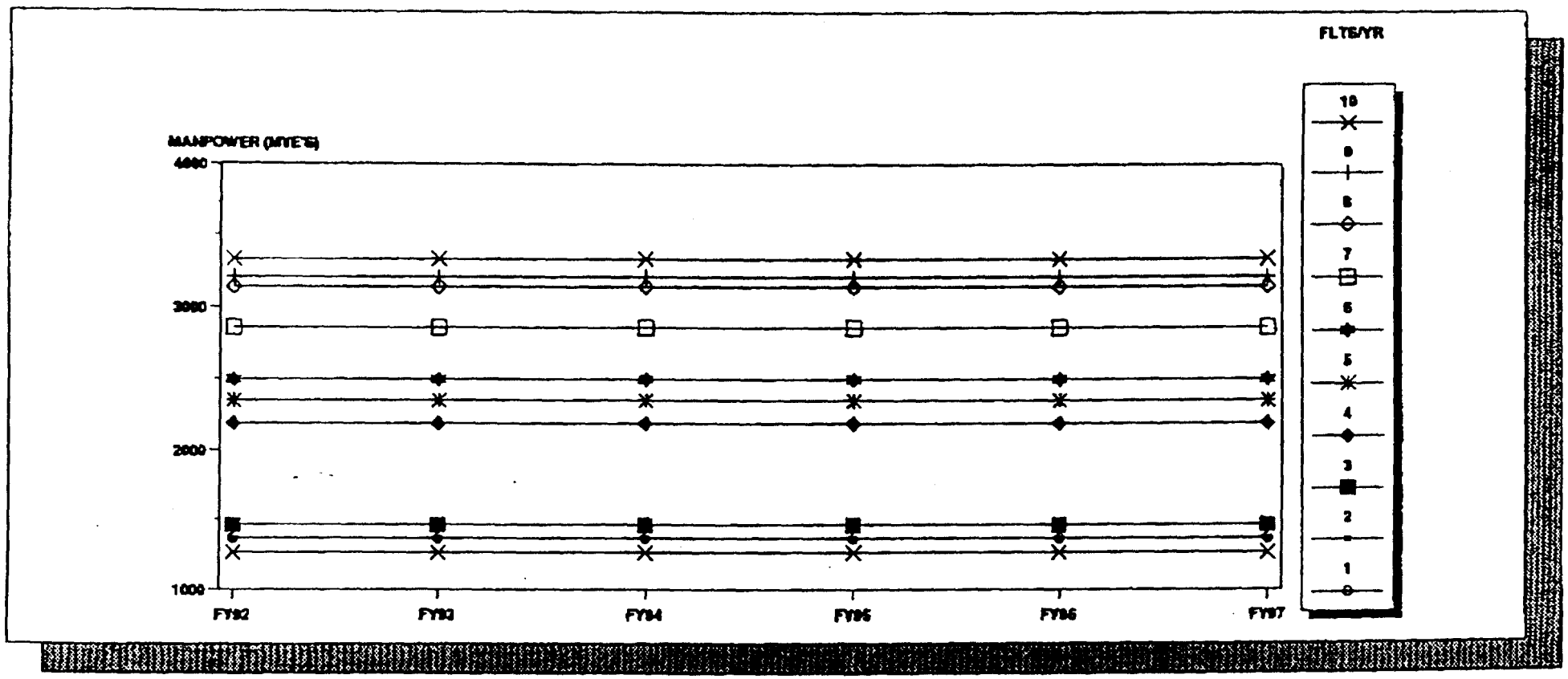
SHUTTLE OPERATIONS COST BY ELEMENT
FY 94 IN RY $$

ELEMENT	1	2	3	4	5	6	7	8	9	10
1.1 SHUTTLE PROC	88.3	95.4	102.3	153.1	164.3	174.6	199.9	219.8	224.5	233.3
1.2 SYSTEMS ENG/SPT	3.8	3.8	3.8	5.6	5.6	5.6	7.7	7.7	9.9	9.9
1.3 FACILITY O & M	64.4	64.4	64.4	87.4	91.2	91.2	122.9	122.9	124.2	124.2
1.4 LPS/INSTRU & CAL	29.5	29.5	29.5	42.1	42.1	42.1	55.5	55.5	55.5	55.5
1.5 OPS MODS	5.1	6.4	6.4	7.4	7.4	7.4	8.3	8.3	8.3	8.3
1.6 TECHNICAL OPS SPT	47.8	57.3	64.2	71.9	81.0	91.3	103.2	116.9	118.0	118.0
1.7 PROGRAM OPS SPT	17.6	21.0	24.4	27.8	31.2	34.6	35.2	35.8	36.1	36.1
1.9 COMMUNICATIONS	13.5	13.5	13.5	19.8	19.8	19.8	23.5	23.5	23.5	23.5
1.14.2 SPECIAL PROJ	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
BOC	15.4	15.9	16.8	18.1	18.9	19.9	20.8	21.3	21.7	21.9
LSS	25.7	29.1	32.6	36.0	39.4	42.5	45.2	47.9	50.6	53.4
PROP	7.7	8.1	9.3	10.5	11.7	12.9	16.2	17.4	18.6	19.8
94 TOTAL	319.0	344.8	367.4	480.0	512.8	542.0	638.7	677.3	691.2	704.0

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.1 -- SHUTTLE PROCESSING



ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.1 -- SHUTTLE PROCESSING

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	1,262	1,262	1,262	1,262	1,262	1,262
2	1,364	1,364	1,364	1,364	1,364	1,364
3	1,461	1,461	1,461	1,461	1,461	1,461
4	2,187	2,187	2,187	2,187	2,187	2,187
5	2,348	2,348	2,348	2,348	2,348	2,348
6	2,495	2,495	2,495	2,495	2,495	2,495
7	2,856	2,856	2,856	2,856	2,856	2,856
8	3,141	3,141	3,141	3,141	3,141	3,141
9	3,208	3,208	3,208	3,208	3,208	3,208
10	3,333	3,333	3,333	3,333	3,333	3,333
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

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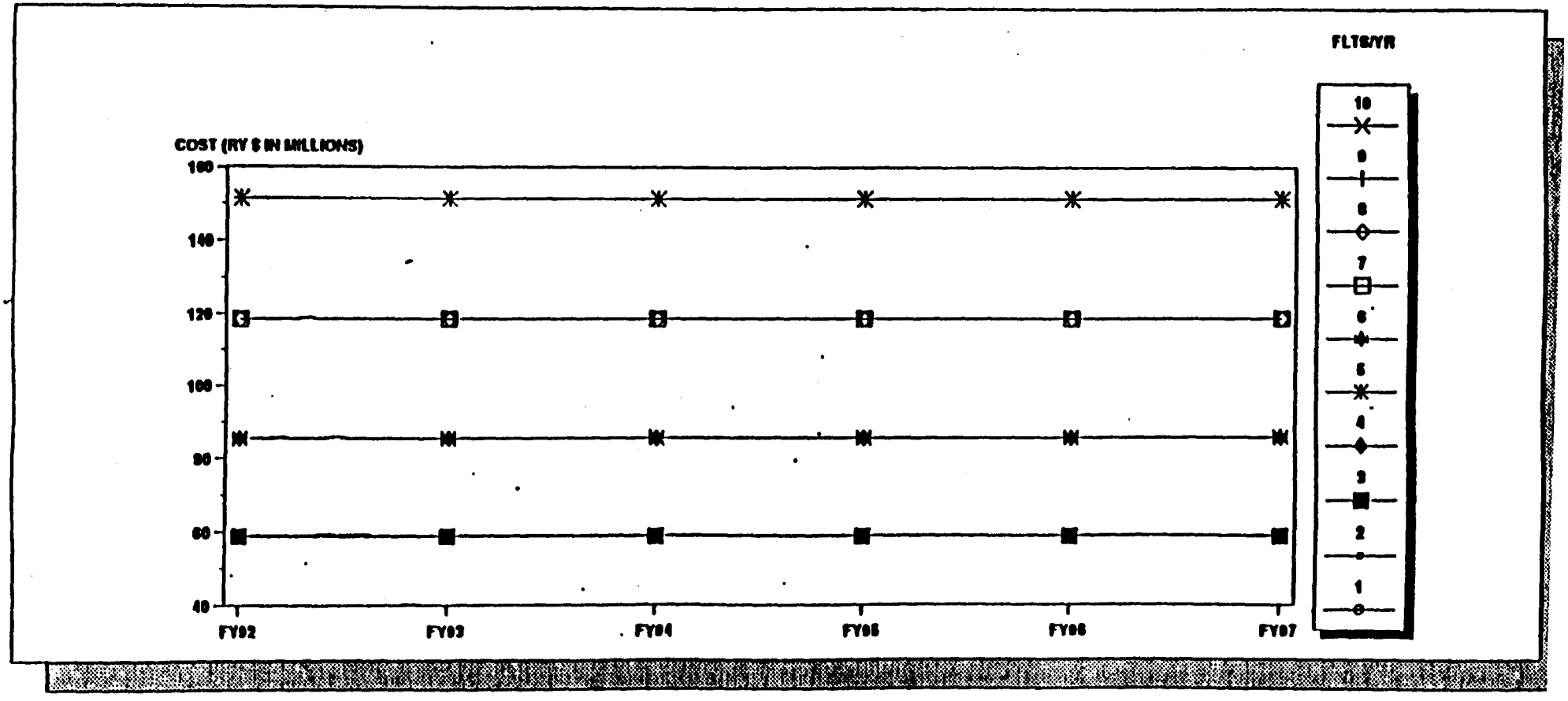
ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.2 -- SYSTEMS ENGINEERING SUPPORT



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC) *(CONTINUED)*

- Maintenance Service Contracts (WBS 1.3.5) – All tasks performed under maintenance service contracts performed by outside vendors and do not support a specific WBS element. This includes fixed service contracts renewed annually for items such as computer maintenance, copier repair and maintenance. Also includes non-recurring repair contracts for material or equipment.
- Inventory Spares and Repair (WBS 1.3.6) – Efforts required to manufacture spare parts and equipment required for Shuttle processing, including issues from Kennedy Inventory Management System (KIMS) for repair either to SPC shop/labs or vendors.
- System Equipment (WBS 1.3.7) – Effort to maintain systems equipment used in the direct or indirect validation of orbiter, payload, external tanks, solid rocket boosters, or on-board systems.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.2 -- SYSTEMS ENGINEERING SUPPORT

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	59	59	59	59	59	59
2	59	59	59	59	59	59
3	59	59	59	59	59	59
4	85	85	85	85	85	85
5	85	85	85	85	85	85
6	85	85	85	85	85	85
7	118	118	118	118	118	118
8	118	118	118	118	118	118
9	151	151	151	151	151	151
10	151	151	151	151	151	151
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

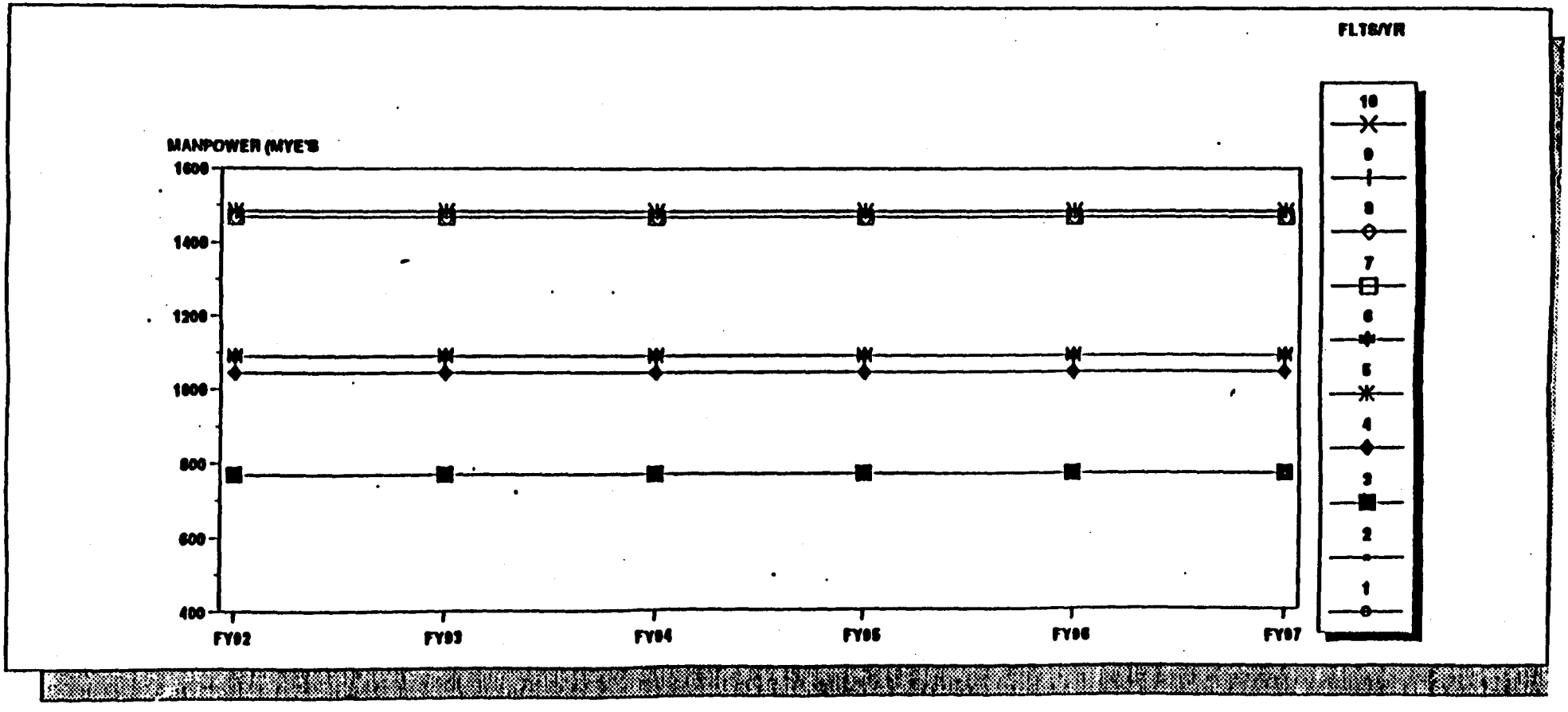
SHUTTLE PROCESSING CONTRACT (SPC)

- **FACILITY OPERATIONS AND MAINTENANCE (WBS 1.3)** -- Work required to operate and maintain Shuttle Processing facilities and support equipment in a manner which will ensure their readiness to support operational processing.
  - ▸ Facility Operation and Maintenance (O&M) Support Operations (WBS 1.3.1) -- Efforts required to integrate and coordinate facility support operations including planning and scheduling O&M activities, overall facility site management and integration.
  - ▸ Facility Maintenance (WBS 1.3.2) -- Efforts to perform facility, systems, and support equipment preventative and corrective maintenance. This includes scheduled repairs, periodic servicing, corrosion control, and response to real-time trouble calls.
  - ▸ Launch Equipment Shops (WBS 1.3.3) -- Efforts to support fabrication and refurbishment for shops and labs required for Shuttle processing. This includes machine shop, assembly and repair, electrical and electronic shops, and pneumatic.
  - ▸ Facility Systems (WBS 1.3.4) -- Operation and maintenance of facility systems including heavy equipment, heating, ventilation, and air conditioning (HVAC), cranes, doors, elevators, platforms, water systems and facility structures.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.3 -- FACILITY OPERATIONS AND MAINTENANCE



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **SYSTEMS ENGINEERING SUPPORT (WBS 1.2)** – Work associated with off-line systems engineering to support Shuttle processing capability.
  - ▸ Engineering Services (WBS 1.2.1) – Efforts required to provide basic documentation services in support of Operational Maintenance Documentation (OMD).
  - ▸ Systems Engineering (WBS 1.2.2) – Efforts required to develop and coordinate the non mission-specific operating procedures, Operations and Maintenance Instructions (OMIs). Also included is the review and coordination of all O&M Requirements and Specifications Documentation (OMRSD).

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.3 – FACILITY OPERATIONS AND MAINTENANCE

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	769	769	769	769	769	769
2	769	769	769	769	769	769
3	769	769	769	769	769	769
4	1,044	1,044	1,044	1,044	1,044	1,044
5	1,089	1,089	1,089	1,089	1,089	1,089
6	1,089	1,089	1,089	1,089	1,089	1,089
7	1,458	1,458	1,458	1,458	1,458	1,458
8	1,458	1,458	1,458	1,458	1,458	1,458
9	1,483	1,483	1,483	1,483	1,483	1,483
10	1,483	1,483	1,483	1,483	1,483	1,483
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

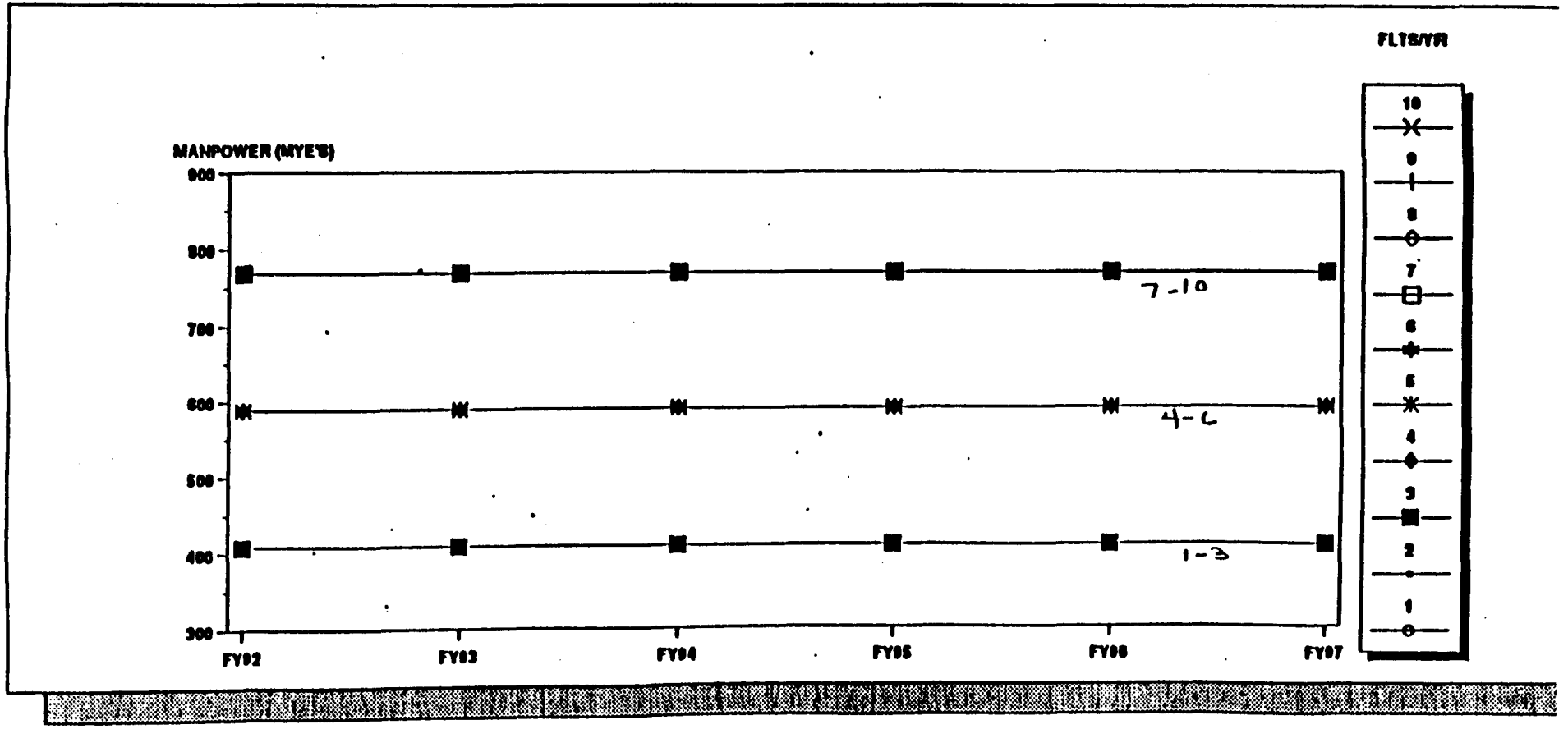
SHUTTLE PROCESSING CONTRACT (SPC)

- **LAUNCH PROCESSING SYSTEM (LPS)/INSTRUMENTATION & CALIBRATION (I&C) (WBS 1.4)** -- All efforts required to support the KSC Launch Processing System (LPS) and the instrumentation and calibration functions required for Shuttle processing.
  - LPS Engineering and Software (1.4.1) -- Efforts required to perform hardware and software engineering, development, maintenance and production for KSC LPS to support Shuttle processing.
  - LPS Operation and Maintenance (O&M) (WBS 1.4.2) -- Efforts required to operate & maintain LPS hardware, software, and firmware for major subsystems, consisting of Checkout, Control, and Monitor Subsystem (CCMS), Central Data Subsystem (CDS) , and Record and Playback Subsystem (RPS).
  - I &C (WBS 1.4.3) -- Efforts required to manage, plan, and perform field/in-place and laboratory calibrations and instrumentation activities required during Shuttle processing. This includes operating & maintaining various instrumentation systems, such as the Environmental & Special Measurement System (ESMS), Lightning Induced Voltage Instrumentation System (LIVIS).

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.4 -- LAUNCH PROCESSING SYSTEM
INSTRUMENTATION & CALIBRATION



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.4 -- LAUNCH PROCESSING SYSTEM
INSTRUMENTATION & CALIBRATION

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	408	408	408	408	408	408
2	408	408	408	408	408	408
3	408	408	408	408	408	408
4	588	588	588	588	588	588
5	588	588	588	588	588	588
6	588	588	588	588	588	588
7	768	768	768	768	768	768
8	768	768	768	768	768	768
9	768	768	768	768	768	768
10	768	768	768	768	768	768
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **MODIFICATIONS (WBS 1.5)** – Efforts required to modify all processing facilities and support equipment in a manner which will ensure their readiness to support Shuttle processing.
  - Shuttle Operations Funded Modifications (WBS 1.5.1) – Effort required to modify facility/systems/ground support equipment, LPS hardware, I&C equipment, and communications equipment. The modifications are reviewed & approved by the SPC Configuration Control Boards.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **TECHNICAL OPERATIONS SUPPORT (WBS 1.6) -- All efforts associated with providing overall technical operations support, for site-wide functions such as Safety, Quality, Logistics, and Operations Management.**
  - **Safety, Reliability, Maintainability, and Quality Assurance (SRM & QA) (WBS 1.6.1) -- All tasks required to provide safety, reliability and maintainability engineering, and overall quality assurance for Shuttle processing activities. Also included are efforts to maintain the Problem Reporting and Corrective Action (PRACA) system and central quality records center.**
  - **Logistics (WBS 1.6.2) -- Efforts required to plan, control, and implement a SPC logistics program. This includes logistics engineering systems and audit, supply management, central shipping and receiving functions associated with the logistics facility, transportation support for equipment pickup/delivery, and managing General Services Administration (GSA) vehicle utilization.**
  - **Facility/Support Equipment Engineering (WBS 1.6.3) -- All sustaining engineering required for Shuttle processing facilities and support equipment. Also included are technical data and documentation services required to operate the Engineering Documentation Center as a central data repository.**
  - **Operations Management (WBS 1.6.4) -- All activities associated with operations management, including manifest planning, flight element change control, and configuration management program.**
  - **Shuttle Processing Data Management System I (SPDMS I) (WBS 1.6.5) -- All effort required to maintain software in support of the SPDMS I.**
  - **Launch Team Training System (LTTS) (WBS 1.6.6) -- All tasks necessary to perform the management and technical effort to design, install, integrate, and sustain the LTTS program at KSC.**
  - **Shuttle Processing Data Management System II (WBS 1.6.7) -- All efforts required to develop and maintain the SPDMS II system & software.**

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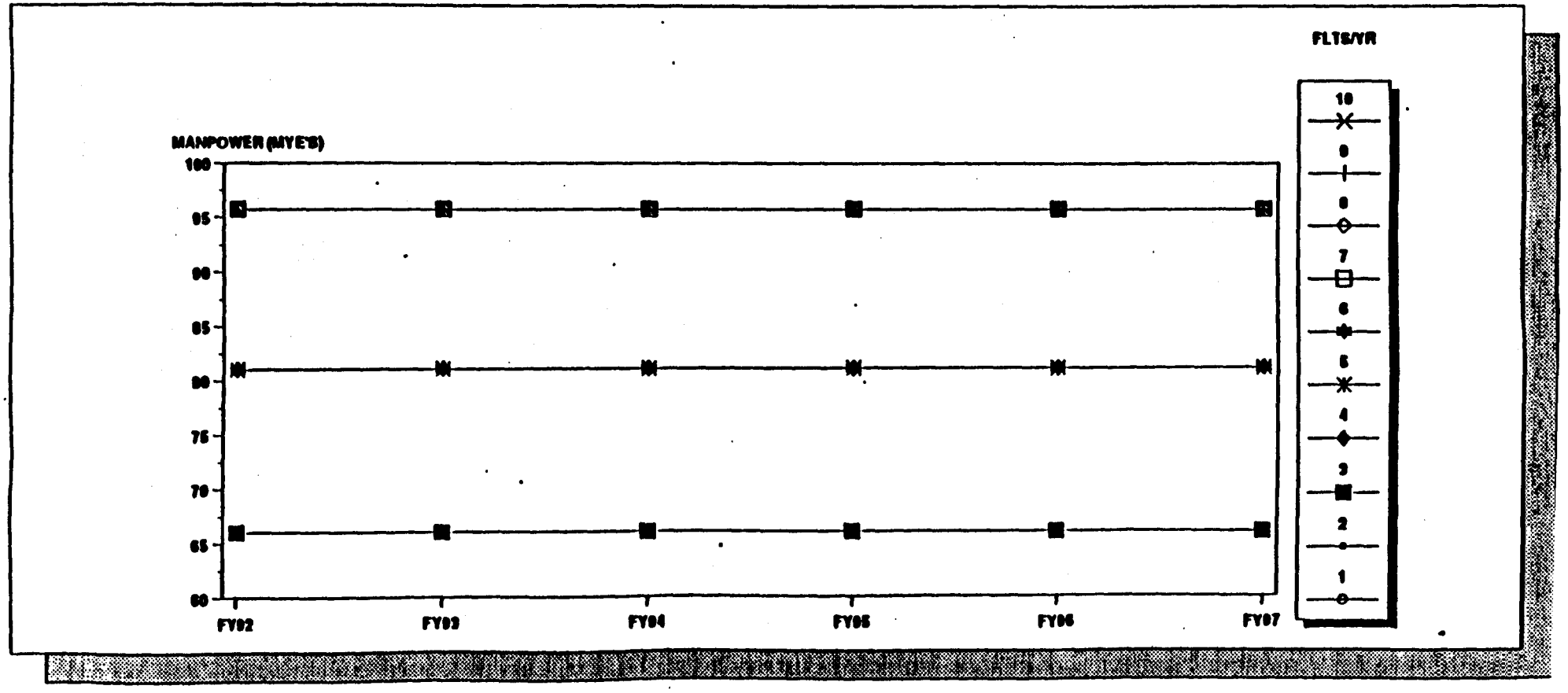
ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.5 -- SHUTTLE OPERATIONS FUNDED MODS



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

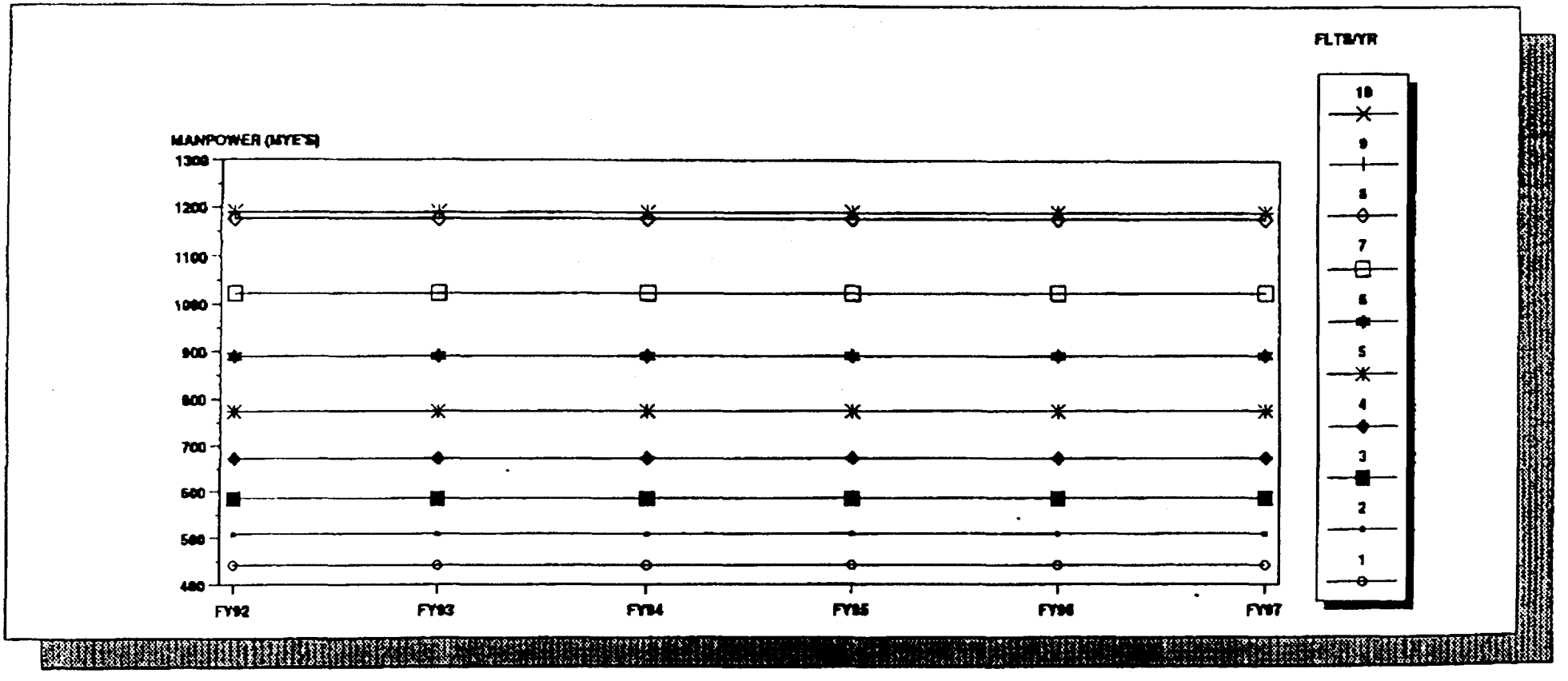
SPC MANPOWER
WBS 1.5 -- SHUTTLE OPERATIONS FUNDED MODS

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	66	66	66	66	66	66
2	66	66	66	66	66	66
3	66	66	66	66	66	66
4	81	81	81	81	81	81
5	81	81	81	81	81	81
6	81	81	81	81	81	81
7	96	96	96	96	96	96
8	96	96	96	96	96	96
9	96	96	96	96	96	96
10	96	96	96	96	96	96
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.6 -- TECHNICAL OPERATIONS SUPPORT



ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

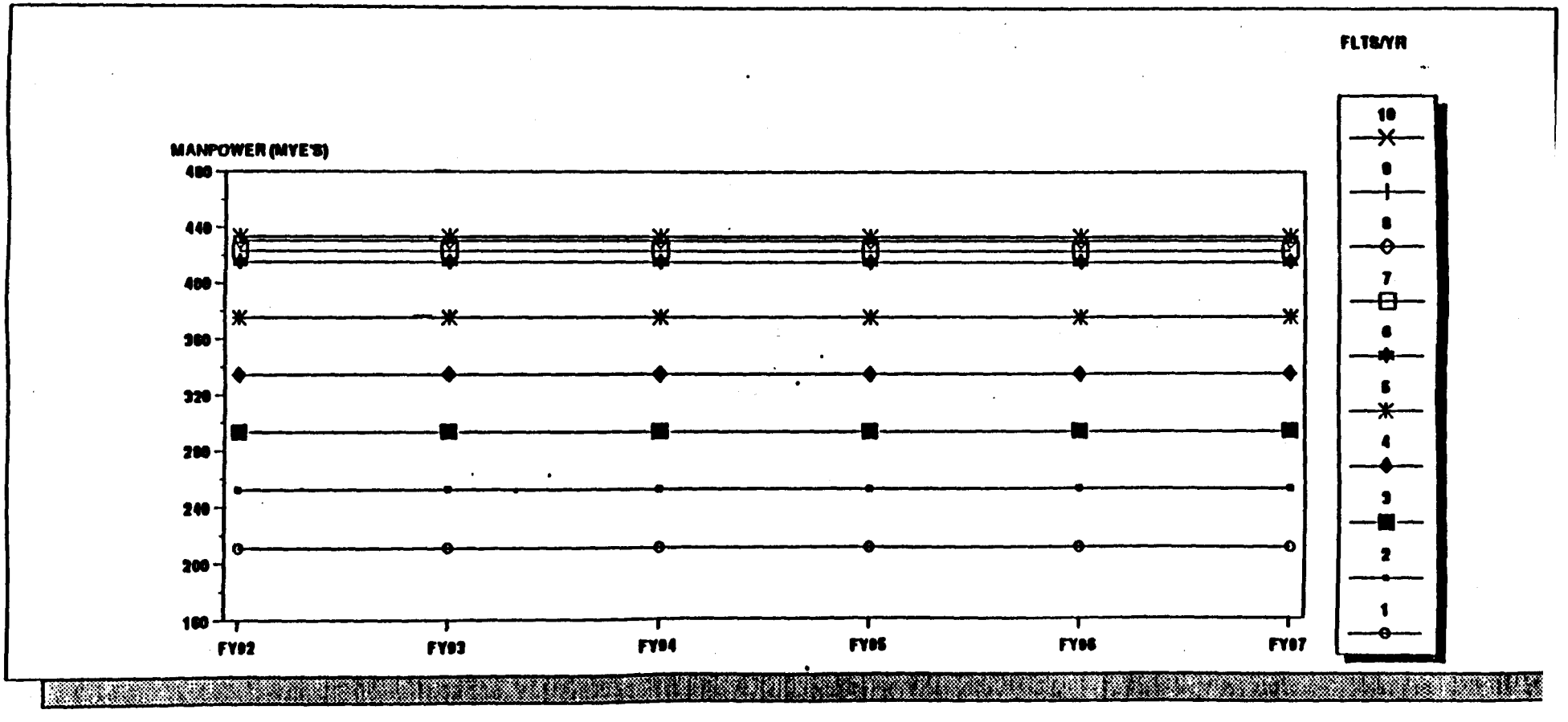
SPC MANPOWER
WBS 1.6 -- TECHNICAL OPERATIONS SUPPORT

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	442	442	442	442	442	442
2	508	508	508	508	508	508
3	585	585	585	585	585	585
4	672	672	672	672	672	672
5	773	773	773	773	773	773
6	889	889	889	889	889	889
7	1,022	1,022	1,022	1,022	1,022	1,022
8	1,175	1,175	1,175	1,175	1,175	1,175
9	1,188	1,188	1,188	1,188	1,188	1,188
10	1,188	1,188	1,188	1,188	1,188	1,188
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.7 -- PROGRAM OPERATIONS SUPPORT



NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **PROGRAM OPERATIONS SUPPORT (WBS 1.7)** – Work Associated with the overall program management and administration operation, including contract/financial management, training, human resources, and physical and industrial security.
  - Program Administration (WBS 1.7.1) – All efforts required to provide overall program operations support including contract/financial management, performance measurement, management planning and procedures, and Team Member management and administration.
  - Training (WBS 1.7.2) – Efforts to provide the necessary management and functional capability to provide a technical training program for SPC, specifically inspection, testing, checkout, and operation of Shuttle systems and equipment.
  - Human Resources (1.7.3) – All efforts required to attract, hire, and retain the requisite skills to meet the overall shuttle processing requirements. This includes providing physical and industrial security functions as well as computer security technical support.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.7 -- PROGRAM OPERATIONS SUPPORT

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	211	211	211	211	211	211
2	252	252	252	252	252	252
3	293	293	293	293	293	293
4	334	334	334	334	334	334
5	375	375	375	375	375	375
6	415	415	415	415	415	415
7	423	423	423	423	423	423
8	430	430	430	430	430	430
9	433	433	433	433	433	433
10	433	433	433	433	433	433
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

SHUTTLE PROCESSING CONTRACT (SPC)

- **COMMUNICATIONS (WBS 1.9)** -- Work associated with the operation and maintenance of communication systems to ensure readiness to support operational flows.
  - ▸ Voice Communications (WBS 1.9.1) -- All efforts required to operate and maintain voice communications for all operational inter-communication system (OIS) equipment, central paging and area warning system, and data voice and radio equipment.
  - ▸ Wideband Transmission and Navigation Aids (WBS 1.9.2) -- All efforts required to operate and maintain wideband transmission and navigation aids for television/teleconference equipment, Kennedy Switched Data Network (KSDN), Tactical Air Command & Navigation System (TACAN), and Microwave Scanning Beam Landing System (MSBLS).
  - ▸ Cable and Wire (WBS 1.9.3) -- Efforts required to Operate and Maintain the KSC cable plant and wire facilities.
  - ▸ Communications Support (WBS 1.9.4) -- All effort required to provide technical operations support to the SPC communications design and operations and maintenance organizations.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.9 -- COMMUNICATIONS

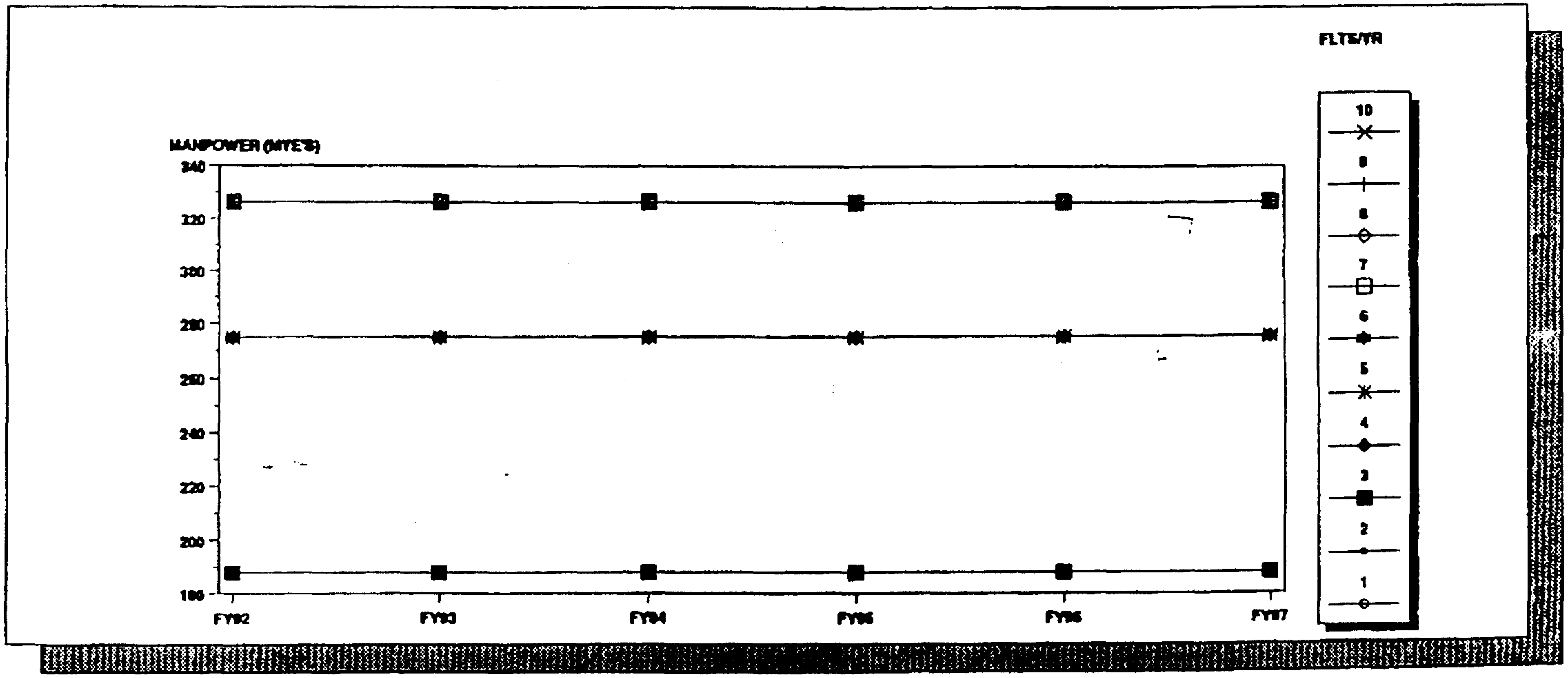
MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	188	188	188	188	188	188
2	188	188	188	188	188	188
3	188	188	188	188	188	188
4	275	275	275	275	275	275
5	275	275	275	275	275	275
6	275	275	275	275	275	275
7	326	326	326	326	326	326
8	326	326	326	326	326	326
9	326	326	326	326	326	326
10	326	326	326	326	326	326
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SPC MANPOWER
WBS 1.9 – COMMUNICATIONS



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

BASE OPERATIONS

- **BASE OPERATIONS CONTRACT (WBS 3.0) -- All efforts required to support Base Operations at the Kennedy Space Center**
  - Propellants and Life Support Systems (WBS 3.1) -- Responsible for the operation and maintenance of propellant and pneumatic systems, and propellant storage and distribution. Effort also includes procuring argon, halon, HCL, IPA, LO2F, NaOH, NH3, refrigerant 21, NH3, refrigerant 21, and solvent 113, and manufacturing BAir, DM Water, GH2, GO2A, GO2F, and LAir.
  - Pressure Vessel Certification (PVC)(WBS 3.2) -- Provides certification of all pressure vessels used by the Base Operations Contract for support to the Shuttle project.
  - Railroad Operations (WBS 3.3) -- Efforts required to operate and maintain the KSC locomotives and railcars.
  - Shuttle Landing Facility Operations (WBS 3.4) -- Responsible for the management and operation of the Shuttle Landing Facility (SLF) in accordance with FAA publications. This includes operating the air traffic control tower, scheduling all aircraft support operations and coordinate required logistics in support of planned flying activities.

NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

LAUNCH SUPPORT SERVICES

- **LAUNCH SUPPORT SERVICES (WBS 4.0)** - All efforts required to support launch services at the Kennedy Space Center.-
  - ▸ Design Engineering (WBS 4.1) -- All Shuttle services provided by the Director of Engineering Development. These services includes the operation and maintenance of CAD/CAE DPS to support tests conducted by the Launch Equipment Test Facility (LETF) and structural design analysis, helicopter engineering support as required by FAA, maintenance of component specification drawings, for the conduct of design investigation studies in support of Shuttle services.
  - ▸ Shuttle Management and Operations (WBS 4.2) -- All Shuttle services obtained directly by the director of Shuttle Management and Operations. Responsible for the Government Furnished Material (GFM) and equipment procurements, retrieval vessel fuel, maintenance and repair contracts (including Artemis and Honeywell CDS), Contingency Landing Site Support and NSTS weather support.
  - ▸ Executive Management (WBS 4.3) -- All Shuttle services obtained directly from the Executive Management Office. Responsible for the Eastern Space and Missile Center (ESMC) support, FAA support, Department of Defense (DoD) support and Helicopter support.
  - ▸ Center Support Operations (WBS 4.4) -- Efforts required to maintain the KSC railroad, including routine maintenance of the railroad bridge operating and signal systems, track switches, grade crossing and signals, and patchwork repairs.

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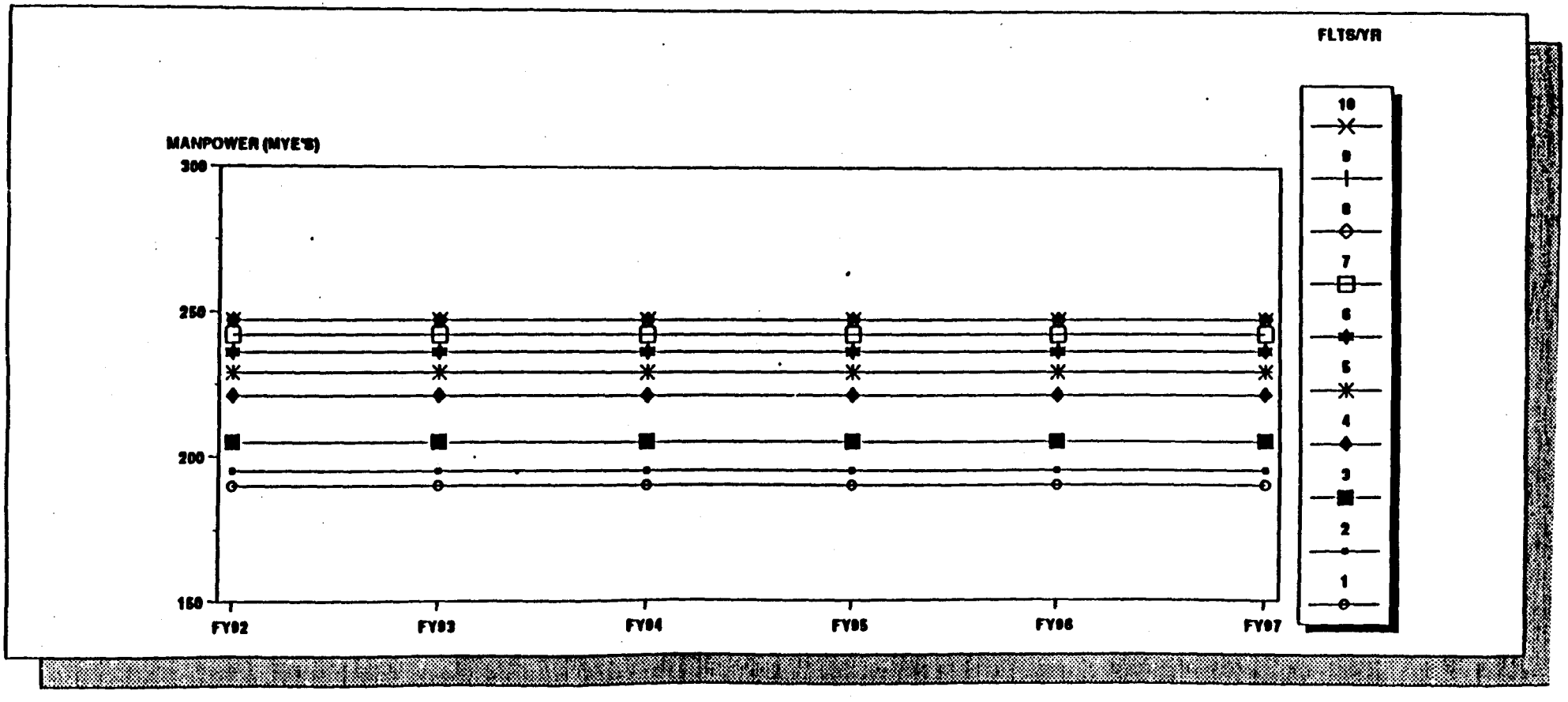
ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

BASE OPERATIONS CONTRACT MANPOWER



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

BASE OPERATIONS CONTRACT MANPOWER

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	190	190	190	190	190	190
2	195	195	195	195	195	195
3	205	205	205	205	205	205
4	221	221	221	221	221	221
5	229	229	229	229	229	229
6	236	236	236	236	236	236
7	242	242	242	242	242	242
8	247	247	247	247	247	247
9	247	247	247	247	247	247
10	247	247	247	247	247	247
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

LAUNCH SUPPORT SERVICES

(CONTINUED)

- Biomedical Operations and Research (WBS 4.5) – Efforts required for the Biomedical Operations and Research Office providing flight nurses, physician support, microbiological sampling and analysis, and clinical laboratory support.
- Safety, Reliability and Quality Assurance (WBS 4.6) – Efforts required for center-wide management of the pressure vessel recertification program which involves the engineering review of new and existing pressure vessel/systems, the maintenance of a database, and the engineering assessment of KSC contractors on their certification of pressure vessels/systems.

NASA

John F. Kennedy Space Center

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

WBS DESCRIPTIONS

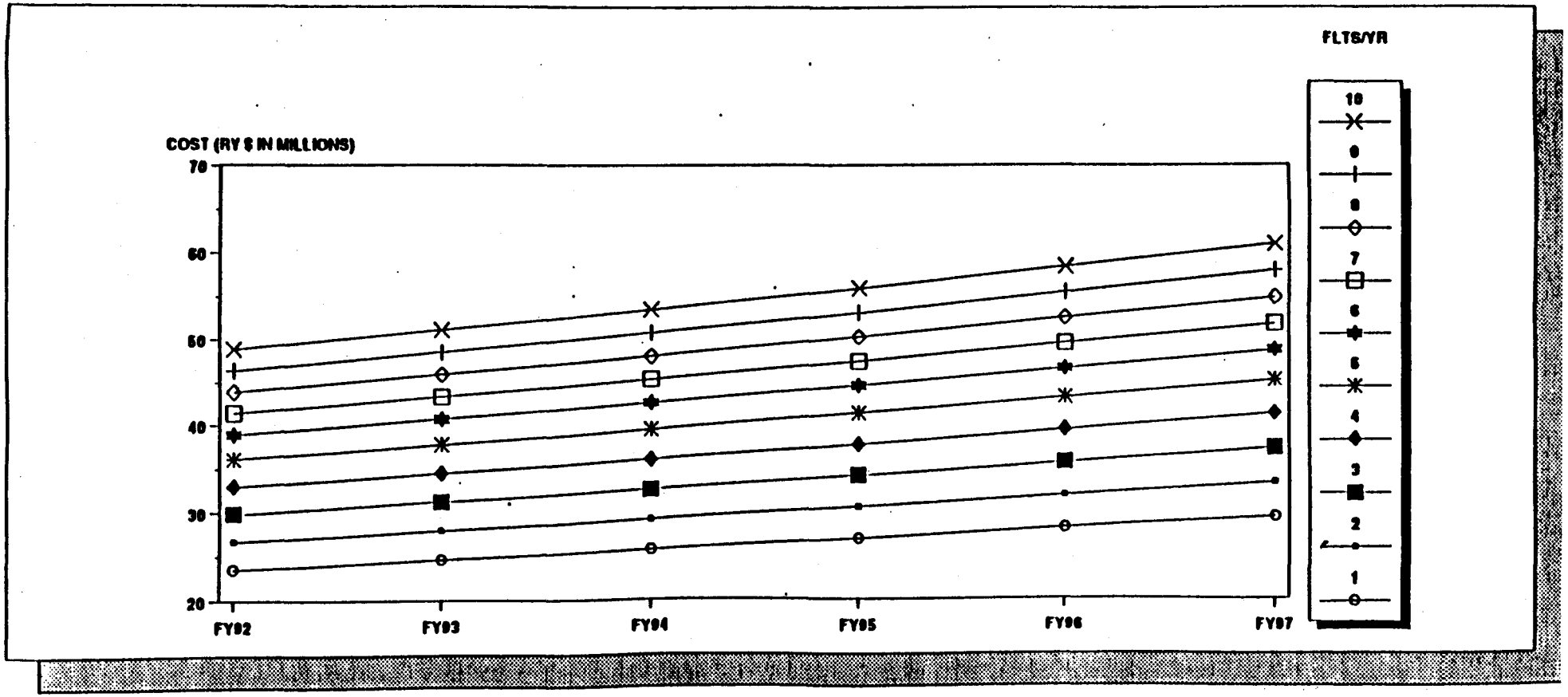
PROPELLANTS

- **PROPELLANTS (WBS 2.0)** -- This effort includes the procurement of all propellants and gases purchased from other government agencies. Propellants include: liquid hydrogen, gaseous helium, gaseous nitrogen, liquid oxygen, hydrazines, and nitrogen tetroxide. Also included is the allocation for the management of the LH2 plant in New Orleans.

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

LSS COST VS. FLIGHT RATE



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ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

LSS COST VS. FLIGHT RATE

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	23.5	24.3	25.6	26.6	27.8	29.0
2	26.7	27.4	28.8	30.1	31.5	32.9
3	29.8	30.7	32.2	33.7	35.2	36.8
4	33.0	33.9	35.7	37.3	38.9	40.7
5	36.1	37.2	39.1	40.8	42.7	44.6
6	38.9	39.4	40.8	42.9	44.9	46.3
7	41.4	42.0	43.5	45.7	47.8	49.3
8	43.9	44.6	46.2	48.6	50.8	52.4
9	46.4	47.1	48.9	51.1	53.7	55.5
10	48.9	49.7	51.6	53.7	56.6	58.6
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

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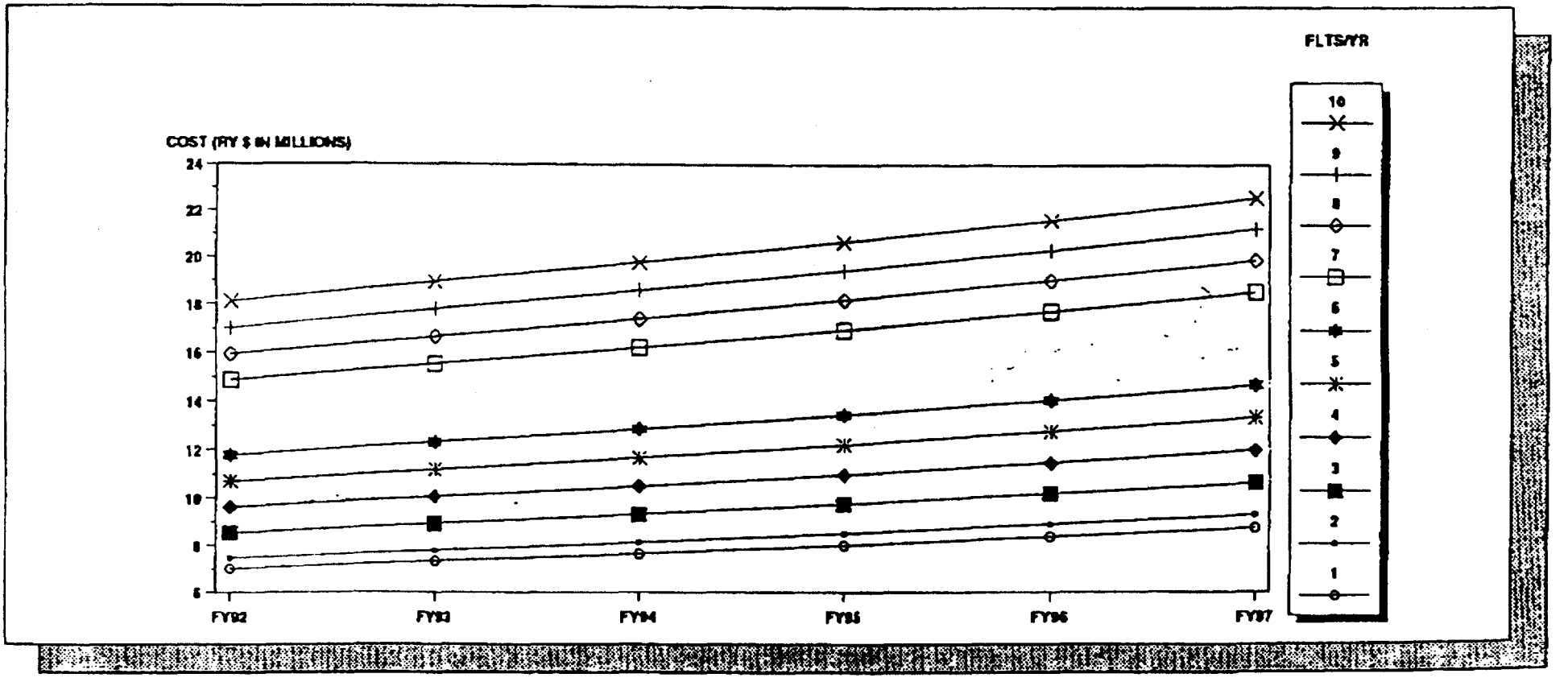
ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

PROPELLENT COST VS FLIGHT RATE



ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

PROPELLENT COST VS FLIGHT RATE

MAXIMUM FLIGHT RATE PER YEAR	FY92	FY93	FY94	FY95	FY96	FY97
1	7.0	7.3	7.7	8.0	8.4	8.7
2	7.5	7.8	8.1	8.5	8.9	9.3
3	8.5	8.9	9.3	9.7	10.2	10.6
4	9.6	10.0	10.5	11.0	11.5	12.0
5	10.7	11.2	11.7	12.2	12.7	13.3
6	11.8	12.3	12.9	13.4	14.0	14.7
7	14.9	15.5	16.2	16.9	17.7	18.5
8	15.9	16.6	17.4	18.2	19.0	19.9
9	17.0	17.8	18.6	19.4	20.3	21.2
10	18.1	18.9	19.8	20.6	21.6	22.5
POP 91-1 FLIGHT RATE	9	9	10	10	10	10

NASA

John F. Kennedy Space Center

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

COST FOR ADDITIONAL MISSION

FLIGHT RATE FROM	TO	FY-94 DELTA COST	PLUS COST TO ACTIVATE *(IF AVAILABLE)*
1	2	$32.0	
2	3	28.3	
3	4	140.6	ORBITERS, OPF BAY, VAB INTEGR CELL, MLP, GSE
4	5	41.1	ET CHECKOUT CELL, GSE
5	6	34.8	
6	7	120.6	ORBITER, OPF BAY, MLP, PAD, GSE
7	8	48.4	
8	9	17.5	ORBITER, GSE
9	10	16.3	

NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

ADDITION OR DELETION OF 1 LAUNCH FROM STEADY STATE RATE

- **ASSUMPTIONS**
  - AT LEAST 2 YEAR NOTIFICATION
  - AVERAGE COMPLEXITY MISSION
  - MISSIONS "EVENLY SPACED" THROUGHOUT THE YEAR AT HIGHER RATE

- **COST SAVINGS FOR DELETED MISSION**
  - ACCEPT PROPOSED POP 90-2 "COST PER FLIGHT" MARGINAL COST DATA
  - $4.8 M IN FY 94 (INCLUDES PROPELLANT $1.2M, SPC $0.7M, BOC $0.2M, LSS $2.7M)

- **COST FOR ADDITIONAL MISSION**
  - COST AT NEXT HIGHER INCREMENTAL LAUNCH RATE FOR 1 1/4 YEARS
  - 12 MONTHS OF "OPERATION" AT NEXT HIGHER LEVEL
  - 3 MONTHS PENALTY COST (INCLUDES HIRING, TRAINING, CERTIFICATION OF PERSONNEL, TERMINATION OF PERSONNEL)

- **ADDITIONAL MISSION CONTINGENT UPON RESOURCE AVAILABILITY**
  - ORBITERS, PAD, MLPs, OPF HI-BAYS NOT MAINTAINED
  - TIME AND COST MAY BE PROHIBITIVE

NASA

ZERO BASE OPERATIONS COST STUDY-C

KSC LAUNCH AND LANDING

SUMMARY

- ZERO BASE STUDY BASED ON LONG TERM, STEADY STATE LAUNCH RATE - DOES NOT APPLY TO NEAR TERM MISSION DELETIONS
- KSC MANPOWER IS FACILITY DRIVEN. REDUCTIONS ARE DEPENDENT UPON GUIDELINE TO "NOT MAINTAIN" ORBITERS, FACILITIES & GSE NOT REQUIRED FOR A GIVEN LAUNCH RATE.

SPACE SHUTTLE MAIN ENGINE PROJECT
ZERO BASE OPERATIONS COST STUDY

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME
GROUNDRULES AND ASSUMPTIONS

- SSME OPERATIONS BUDGET IS 34% OF THE TOTAL SSME PROJECT BUDGET
- ASSUME PRODUCTION REMAINS AS IN THE POP 91-1, SSME HAS 19 ENGINES ON CONTRACT AT PRESENT, INCLUDING OV-105 ENGINES
- ANY VARIATION TO THE PRESENT PRODUCTION BUDGET WILL PERTURB THIS EXERCISE
- ASSUMED A MINIMUM SPARES CAPABILITY OF ONE EQUIVALENT ENGINE BUILD PER YEAR
- OVERHEAD IMPACT NOT CONSIDERED

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

ADVANTAGES FROM PRODUCTION FOR OPERATIONS

- TESTING BOTH DEVELOPMENT AND ACCEPTANCE
- FLIGHT RETROFIT OF HARDWARE:
  - PHASE 2 +
  - SINGLE COIL HEAT EXCHANGER
  - ALTERNATE TURBOPUMP
- NEW ATTRITION ENGINES
- MANPOWER - BOTH HANDS-ON AND SUPPORT
  - MINIMUM SKILL LEVELS

ZERO BASE OPE ATIONS COST STUDY
MSFC – SPACE SHUTTLE MAIN ENGINE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	
SSME	ANOMALY RESOLUTION	17.7	17.7	17.7	20.2	20.2	20.2	21.5	21.5	22.4	22
SSME	FLIGHT SUPPORT	20.1	20.1	20.1	24.9	24.9	24.9	26.6	26.6	27.4	27
SSME	LOGISTICS CANOGA	3.3	3.3	3.3	6.4	6.4	6.4	6.4	6.4	6.4	6
SSME	SPARES	45.4	45.4	45.4	48.8	52.3	55.8	59.3	62.8	66.3	69
SSME	REFURBISHMENT	5.2	5.2	5.2	7.0	8.7	10.5	12.2	14.0	15.7	17
	TOTAL	91.7	91.7	91.7	107.3	112.5	117.8	126.0	131.3	138.2	14

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

ANOMALY RESOLUTION

- MANPOWER, MATERIALS, AND SERVICES TO SUPPORT ANALYSIS OF SSME HARDWARE ANOMALIES
- EXCLUDES ANALYSIS OF HARDWARE UNIQUE TO THE DEVELOPMENT PROGRAM

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

FLIGHT SUPPORT

- PRE/POST FLIGHT ANALYSIS AND SUPPORT
- HI/HR CRITICAL SKILLS AND DEPOT SUPPORT
- LAUNCH SUPPORT SERVICES (LSS)
- CIL CONTROL/MAINTENANCE
- HSL (EXCLUDES APPROXIMATELY 50% HSL EFFORT COVERED UNDER BLOCK II CONTROLLER)
- WELD DEFECT REPORTING
- AUTOMATED CYCLE TIME SYSTEM (ACTS)
- PROBLEM REPORTING AND MANAGEMENT SYSTEM (PRAMS)

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

LOGISTICS - CANOGA

- LOGISTICS ENGINEERING, SUPPLY SUPPORT, WAREHOUSING AND INVENTORY MANAGEMENT, AND GROUND OPERATIONS TRAINING
  - FIELD SUPPORT, MANUAL MAINTENANCE, AND TRAINING
  - SPARES PROVISIONING, DEPOT WAREHOUSING, AND ENGINE COMPONENT OVERHAUL

MSFC

ZERO BASE OPERATIONS COST STUDY
SSME

SPARES

- NEW HARDWARE REQUIRED TO SUPPORT FLIGHT
  - INCLUDES MAJOR COMPONENTS SUCH AS POWERHEAD, MCC, NOZZLE, AS WELL AS ALL AVIONICS, VALVES, AND ACTUATORS
  - ALSO INCLUDES MISCELLANEOUS HARDWARE THAT IS EXPENDED EACH FLIGHT (APPROXIMATELY 300K)
- POP 91-1 REQUIREMENTS ARE BASES FOR ESTIMATION OF COMPONENT MTBF LIFE LIMITS, INITIAL STATE, DAR LIMITS, ATTRITION, FLIGHT RATE, AND 90% POS FOR SPARE HARDWARE
- EXPOSURE TIME, AS WELL AS NUMBER OF ENGINES REQUIRED FOR FLIGHT RATE, DETERMINED LEVEL OF SPARE HARDWARE
  - MUST MAINTAIN 90% POS
  - AMPLE NUMBER OF SPARES MUST BE MAINTAINED TO INSURE FLIGHT CAPABILITY
- REQUIREMENTS FOR SPARE ENGINES, AS WELL AS ATTRITION ENGINES, ARE COVERED UNDER PRODUCTION (UPN 553) THESE ENGINES ARE ALREADY ON CONTRACT AND ARE PART OF INITIAL STATE

MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

LOGISTICS - CANOGA

- LOGISTICS ENGINEERING, SUPPLY SUPPORT, WAREHOUSING AND INVENTORY MANAGEMENT, AND GROUND OPERATIONS TRAINING
  - FIELD SUPPORT, MANUAL MAINTENANCE, AND TRAINING
  - SPARES PROVISIONING, DEPOT WAREHOUSING, AND ENGINE COMPONENT OVERHAUL

MSFC

ZERO BASE OPERATIONS COST STUDY
SSME

SPARES

- NEW HARDWARE REQUIRED TO SUPPORT FLIGHT
  - INCLUDES MAJOR COMPONENTS SUCH AS POWERHEAD, MCC, NOZZLE, AS WELL AS ALL AVIONICS, VALVES, AND ACTUATORS
  - ALSO INCLUDES MISCELLANEOUS HARDWARE THAT IS EXPENDED EACH FLIGHT (APPROXIMATELY 300K)
- POP 91-1 REQUIREMENTS ARE BASES FOR ESTIMATION OF COMPONENT MTBF LIFE LIMITS, INITIAL STATE, DAR LIMITS, ATTRITION, FLIGHT RATE, AND 90% POS FOR SPARE HARDWARE
- EXPOSURE TIME, AS WELL AS NUMBER OF ENGINES REQUIRED FOR FLIGHT RATE, DETERMINED LEVEL OF SPARE HARDWARE
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  - AMPLE NUMBER OF SPARES MUST BE MAINTAINED TO INSURE FLIGHT CAPABILITY
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MSFC
ZERO BASE OPERATIONS COST STUDY
SSME

REFURBISHMENT

- REPAIR AND OVERHAUL FLIGHT ENGINES AND MAJOR FLIGHT COMPONENTS
  - FLIGHT EXPOSURE DRIVEN
  - LABOR AND MINOR HARDWARE
  - NO NEW HARDWARE PURCHASED IN THIS CATEGORY

ZERO BASE OPERATIONS COST STUDY
SSME
MAJOR DRIVERS TO THE MINIMUM BASE

FLIGHTS/YEAR	RATIONALE	
BASE (1-3 FLIGHTS)	• SPARES/REFURBISHMENT	- CRITICAL SKILLS FOR MANUFACTURING - PRODUCTION BUDGET REMAINS INTACT; OPERATIONS ASSUMED TO REQUIRE MINIMUM SKILLS FOR ONE EQUIVALENT ENGINE BUILD PER YEAR
	• FLIGHT SUPPORT	- CRITICAL SKILLS FOR ENGINEERING
	• ANOMALY RESOLUTION	- CRITICAL SKILLS FOR ENGINEERING
	• LOGISTICS @ CANOGA	- CRITICAL SKILLS FOR ENGINEERING

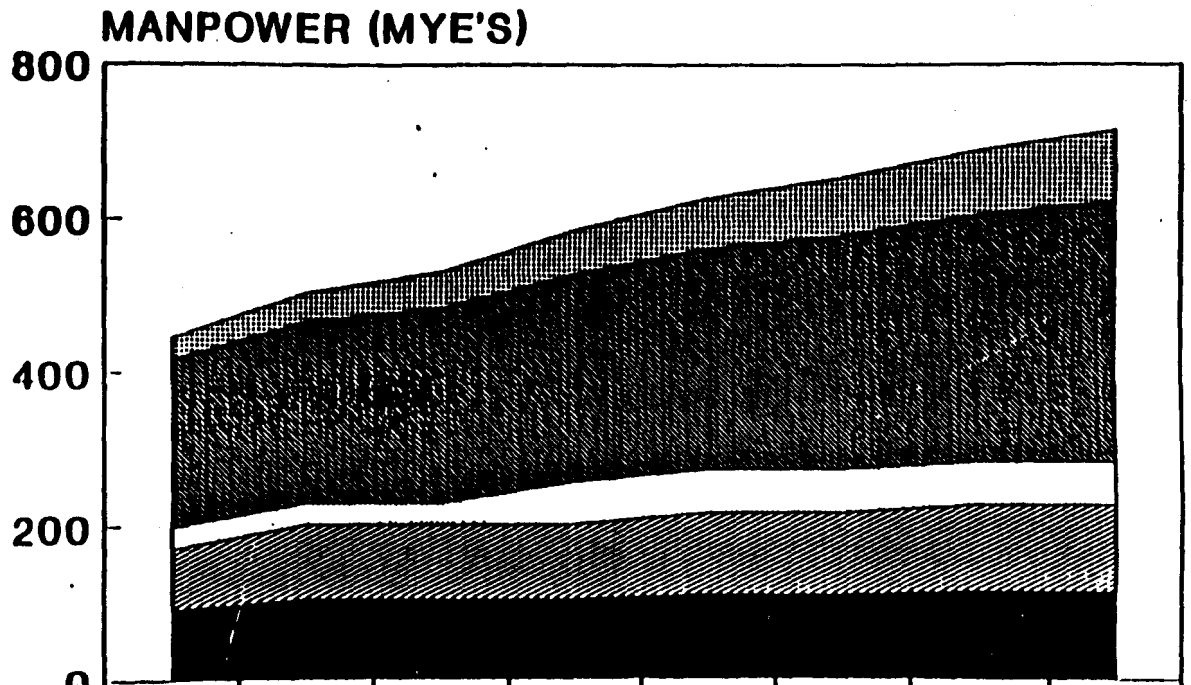
SSME

ZERO BASE OPERATIONS COST STUDY

FLIGHT INCREMENT DRIVERS

4 FLTS/YR	• ADDITIONAL ENGINEERING AND SUPPORT MANPOWER FOR FLIGHT SUPPORT, ANOMALY RESOLUTION & LOGISTICS
	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE COST BASED ON HIGHER HARDWARE EXPOSURE TIME
5-6 FLTS/YR	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE COST BASED ON HIGHER HARDWARE EXPOSURE TIME
7 FLTS/YR	• ADDITIONAL ENGINEERING AND SUPPORT MANPOWER FOR FLIGHT SUPPORT AND ANOMALY RESOLUTION
	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE COST BASED ON HIGHER HARDWARE EXPOSURE TIME
8 FLTS/YR	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE COST BASED ON HIGHER HARDWARE EXPOSURE TIME
9 FLTS/YR	• ADDITIONAL MANPOWER FOR FLIGHT SUPPORT AND ANOMALY RESOLUTION
	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE BASED ON HIGHER HARDWARE EXPOSURE TIME
10 FLTS/YR	• ADDITIONAL REFURBISHMENT AND SPARES HARDWARE BASED ON HIGHER HARDWARE EXPOSURE TIME

ZERO BASE OPERATIONS COST STUDY
SSME
MANPOWER SUMMARY BY ELEMENT



	3	4	5	6	7	8	9	10
REFURBISHMENT	28	37	47	56	65	75	84	93
SPARES	220	238	255	272	289	306	323	340
LOGISTICS	27	27	27	54	54	54	54	54
FLIGHT SUPPORT	79	97	97	97	106	106	112	112
ANOM RESOLUTION	92	105	105	105	111	111	116	116

FLIGHT RATE

SPACE SHUTTLE PROGRAM OFFICE
ZERO BASE OPERATIONS COST STUDY

ZERO BASE OPERATIONS COST STUDY
SPACE SHUTTLE PROGRAM OFFICE

GROUNDRULES & ASSUMPTIONS

GENERAL

- 0 ASSUME SYSTEM INTEGRATION/PAYLOAD CARGO INTEGRATION NOT IMPACTED BY POTENTIAL CONTRACT RECOMPETITION
- 0 ASSUME ROCKWELL TOTAL BUSINESS BASE STABLE OR RATE INCREASES ACCOMMODATED BY APA FUNDING
- 0 OVERALL FLIGHT RATE CAPABILITY AT ZERO BASE REFFLECTS COMPOSITE OF FUNCTIONAL DISCIPLINES WITH DIFFERENT MINIMUM CRITICAL SKILLS LEVELS

ENGINEERING INTEGRATION

- 0 ASSUME NO TASK RESTRUCTURING AS A RESULT OF RI COST REDUCTION INITIATIVE
- 0 CURRENT SYSTEM INTEGRATION FLIGHT SUPPORT TEMPLATE IS 20 MONTHS PRE-FLIGHT AND 4 MONTHS POST-FLIGHT

INTEGRATION AND OPERATIONS

- 0 ASSUME 19.5 MONTH STANDARD PAYLOAD/CARGO INTEGRATION MISSION PRODUCT FLOW GENERIC TEMPLATE
- 0 ASSUME 28 MONTH PAYLOAD ICD DEVELOPMENT TEMPLATE ASSUMING AN AVERAGE OF 2 NEW PAYLOAD ICD'S PER FLIGHT. DOES NOT INCLUDE EXTENDED TEMPLATE (58 MONTHS) FOR SPACE STATION FREEDOM ICD DEVELOPMENT

MANAGEMENT INTEGRATION

- 0 SINGLE SHIFT OPERATIONS
- 0 PRCB WILL OPERATE AS NORMAL FOR FLIGHT VEHICLES
- 0 EXISTING INFORMATION SYSTEMS AND PROCESSES WILL REMAIN ACTIVE
- 0 IMPROVEMENTS TO SYSTEM AND PROCESSES WILL CONTINUE TO BE MADE

27-Jun-91

ZERO BASE OPERATIONS COST STUDY
SPACE SHUTTLE PROGRAM OFFICE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE									
		1	2	3	4	5	6	7	8	9	10
ENG INTEG	TECHNICAL SUPPORT	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
ENG INTEG	FLIGHT SUPPORT	35.4	35.4	35.4	35.4	37.3	39.2	41.1	43.1	45.0	47.0
ENG INTEG	ADMINISTRATIVE SUPPORT	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
ENG INTEG	DEVELOPMENT FOR OPERATIONS	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	SUBTOTAL	89.5	89.5	89.5	89.5	91.4	93.3	95.2	97.2	99.1	101.1
INTEG OPS	P/L INTERFACE /CARGO INTEG DOC	5.2	6.1	6.8	8.0	9.0	9.7	10.7	11.5	12.2	12.8
INTEG OPS	CARGO INTERFACE ANALYSIS	8.7	8.7	9.9	12.2	14.2	16.9	19.6	22.3	25.1	27.9
INTEG OPS	CARGO INTEG MANAGEMENT	2.7	2.8	2.8	3.3	3.9	4.9	5.4	5.9	6.1	6.1
INTEG OPS	PAYLOAD/CARGO INTEG ROMS	2.2	2.2	2.5	2.9	3.0	3.6	3.8	3.8	4.1	4.1
INTEG OPS	STSOC PROJECT SUPPORT	5.4	5.4	5.5	6.3	6.9	7.4	8.2	8.7	9.2	9.9
INTEG OPS	MISC EQUIPMENT/OTHER	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
	SUBTOTAL	27.9	28.9	31.2	36.4	40.7	46.2	51.4	55.9	60.4	64.5
MGMT INTEG	CONFIGURATION MANAGEMENT	8.6	9.0	9.8	10.0	10.6	11.2	11.4	11.6	11.9	11.9
MGMT INTEG	INFORMATION MANAGEMENT	9.9	10.1	10.4	10.6	10.6	11.1	11.1	11.1	11.1	11.1
MGMT INTEG	EQUIPMENT & SERVICES	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
MGMT INTEG	OTHER SUPPORT TO KSC,HQ	0.4	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
	SUBTOTAL	22.9	23.7	24.8	25.2	26.0	27.1	27.3	27.5	27.8	27.8
	TOTAL	140.3	142.1	145.5	151.1	158.1	166.6	173.9	180.6	187.3	193.4

27-Jun-91

ZERO BASE OPERATIONS COST STUDY
SPACE SHUTTLE PROGRAM OFFICE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE									
		1	2	3	4	5	6	7	8	9	10
ENG INTEG	TECHNICAL SUPPORT	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
ENG INTEG	FLIGHT SUPPORT	35.4	35.4	35.4	35.4	37.3	39.2	41.1	43.1	45.0	47.0
ENG INTEG	ADMINISTRATIVE SUPPORT	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
ENG INTEG	DEVELOPMENT FOR OPERATIONS	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	SUBTOTAL	89.5	89.5	89.5	89.5	91.4	93.3	95.2	97.2	99.1	101.1
INTEG OPS	P/L INTERFACE /CARGO INTEG DOC	5.2	6.1	6.8	8.0	9.0	9.7	10.7	11.5	12.2	12.8
INTEG OPS	CARGO INTERFACE ANALYSIS	8.7	8.7	9.9	12.2	14.2	16.9	19.6	22.3	25.1	27.9
INTEG OPS	CARGO INTEG MANAGEMENT	2.7	2.8	2.8	3.3	3.9	4.9	5.4	5.9	6.1	6.1
INTEG OPS	PAYLOAD/CARGO INTEG ROMS	2.2	2.2	2.5	2.9	3.0	3.6	3.8	3.8	4.1	4.1
INTEG OPS	STSOC PROJECT SUPPORT	5.4	5.4	5.5	6.3	6.9	7.4	8.2	8.7	9.2	9.9
INTEG OPS	MISC EQUIPMENT/OTHER	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
	SUBTOTAL	27.9	28.9	31.2	36.4	40.7	46.2	51.4	55.9	60.4	64.5
MGMT INTEG	CONFIGURATION MANAGEMENT	8.6	9.0	9.8	10.0	10.6	11.2	11.4	11.6	11.9	11.9
MGMT INTEG	INFORMATION MANAGEMENT	9.9	10.1	10.4	10.6	10.6	11.1	11.1	11.1	11.1	11.1
MGMT INTEG	EQUIPMENT & SERVICES	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
MGMT INTEG	OTHER SUPPORT TO KSC,HQ	0.4	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
	SUBTOTAL	22.9	23.7	24.8	25.2	26.0	27.1	27.3	27.5	27.8	27.8
	TOTAL	140.3	142.1	145.5	151.1	158.1	166.6	173.9	180.6	187.3	193.4

ZERO BASE OPERATIONS COST STUDY

SPACE SHUTTLE ENGINEERING INTEGRATION

MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLTS/YR	RATIONALE
1-4 (BASE)	• TECHNICAL SUPPORT (WBS 39.1) • FLIGHT DESIGN ANALYSIS SUPPORT • TECHNICAL DATABASE & DATABOOK MAINTENANCE • AVIONICS SYSTEM INTEGRATION • FLIGHT SOFTWARE REQUIREMENTS INTEGRATION • FLIGHT SUPPORT (WBS 39.2) • CONFIGURATION REQUIREMENTS INTEGRATION • OMRSD/LCC • MSR & POST FLIGHT ANALYSIS • FLIGHT DESIGN & MARGIN ANALYSIS • ASCENT FLIGHT SOFTWARE REQUIREMENTS • ADMINISTRATIVE SUPPORT (WBS 39.3) • BUSINESS MANAGEMENT • PROJECT ENGINEERING/MANAGEMENT • OFF-SITE SUPPORT • DEVELOPMENT FOR OPERATIONS (WBS 39.4) • AERO DATABASE/INSTRUMENTATION
5-10 (INCREMENTS)	• FLIGHT SUPPORT (WBS 39.2) EQUAL COST INCREMENTS ESTABLISHED FOR PER FLIGHT INCREASES ABOVE BASE BY LINEARIZING FRACTIONAL SUPPORT OF 44 SKILLS REPRESENTING 33 FLIGHT SUPPORT TASKS

ZERO BASE OPERATIONS COST STUDY

SPACE SHUTTLE ENGINEERING INTEGRATION TECHNICAL SUPPORT (WBS 39.1)

METRICS

- GROUND SYSTEM INTEGRATION - GSE UTILIZATION LIST, GROUND SYSTEM DESIGN PACKAGES
- LEVEL II ICD'S & SCHEMATICS - ELEMENT-ELEMENT & ELEMENT-GROUND ICD'S, SSP FLIGHT SYSTEM INTEGRATED SCHEMATICS
- INTEGRATED LOGISTICS SUPPORT - INTEGRATED LOGISTICS PANEL ACTIONS
- FLIGHT DESIGN ANALYSIS SUPPORT - ACTIONS FROM LEVEL II TECHNICAL PANELS & WORKING GROUPS
- PCASS SUPPORT - DATABASE INTERFACE, DATA TRANSFER & REPORT GENERATION SOFTWARE
- ENGINEERING ANALYSIS & LSEAT CONFIG MGMT - ANALYTICAL PROCESSES, DATABASES, COMPUTER PROGRAMS
- TECHNICAL DATABASE & DATABOOK MAINTENANCE - DATABASE & DATABOOK UPDATES
- LEVEL II CHANGE REQUEST ASSESSMENT - LEVEL II CHANGE EVALUATIONS
- LEVEL II SAFETY/HAZARDS ANALYSIS - ANALYSES, EVALUATIONS, BRIEFINGS
- PROBLEM ASSESSMENT/TRENDING - LEVEL II PROBLEM REPORTS
- AVIONICS SYSTEM INTEGRATION - AVIONICS & SOFTWARE CHANGE EVALUATIONS
- FLIGHT SOFTWARE REQUIREMENTS INTEGRATION - AVIONICS & SOFTWARE CHANGE TRAFFIC

ZERO BASE OPERA..ONS COST STUDY

SPACE SHUTTLE ENGINEERING INTEGRATION
FLIGHT SUPPORT (WBS 39.2)
METRICS

- CONFIGURATION REQUIREMENTS INTEGRATION - SSV CONFIGURATION BASELINE & CHANGES
- OMRSD/LCC - OMRSD & LCC REQUIREMENTS CHANGE PAPER
- MSR & POST FLIGHT ANALYSIS - REAL-TIME & POSTFLIGHT SSV PERFORMANCE DATA
- FLIGHT DESIGN & MARGIN ANALYSIS - SYSTEM INTEGRATION ASCENT FLIGHT COFR REQUIREMENTS
- RVAS & COFR SUPPORT - REQUIREMENTS ACCOUNTING DATABASE RECORDS
- MASS PROPERTIES - MASS PROPERTIES DATABASE RECORDS
- LSEAT - DATABASES & ANALYTICAL PROGRAMS
- OMI/TOPS REVIEW - KSC WORK REQUIREMENTS & IMPLEMENTATION PAPER
- ASCENT FLIGHT SOFTWARE REQUIREMENTS - SAIL TEST SHIFTS, FSSR & PRD UPDATES
- MAST SUPPORT - SSV & MISSION DATA CHANGES
- FLIGHT DATA FILE & FLIGHT RULES ASSESSMENT - FLIGHT DATA FILE & FLIGHT RULES CHANGE PAPER

ZERO BASE OPERATIONS COST STUDY

SPACE SHUTTLE ENGINEERING INTEGRATION ADMINISTRATIVE SUPPORT (WBS 39.3)

METRICS

- **BUSINESS MANAGEMENT - FINANCIAL REPORTS & CHANGE PAPER**
- **PROJECT ENGINEERING/MANAGEMENT - CONTRACT TASKS & SCHEDULES, LEVEL II MEETINGS & CHANGE PAPER**
- **OFF-SITE SUPPORT - OFF-SITE CONTRACT TASKS**

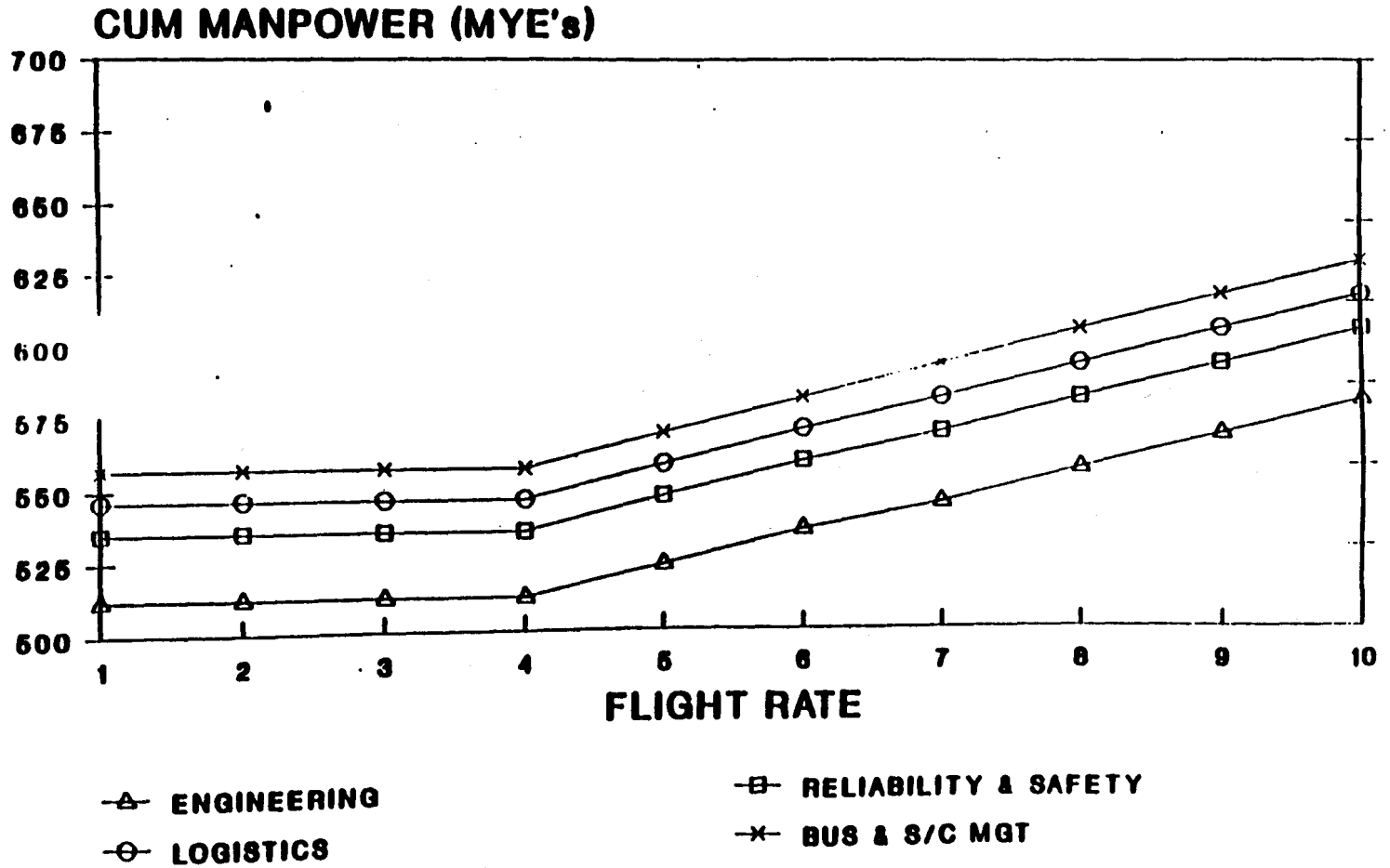
ZERO BASE OPERATIONS COST STUDY

SPACE SHUTTLE ENGINEERING INTEGRATION DEVELOPMENT FOR OPERATIONS SUPPORT (WBS 39.4)

METRICS

- AERO DATABASE/INSTRUMENTATION - TEST REQUIREMENTS, SSP INSTRUMENTATION
- LOADS ENVIRONMENTS/ANALYSIS - SSV PROGRAM CHANGES AFFECTING INTEGRATED LOADS ENVIRONMENTS
- OPERATIONAL TOOLS DEVELOPMENT - TECHNICAL ANALYSIS PROCESSES, DATABASES, COMPUTER PROGRAMS
- OTHER - DOLILU ANALYSIS REQUIREMENTS

ZERO BASE OPERATIONS COST STUDY
SPACE SHUTTLE ENGINEERING INTEGRATION
MANPOWER SUMMARY BY FUNCTION-FY94



ZERO BASE OPERATIONS COST STUDY

INTEGRATION AND OPERATIONS
PAYLOAD/CARGO INTEGRATION
TASK PERFORMED BY WBS

- PAYLOAD INTERFACE ANALYSIS/CARGO INTEGRATION DOCUMENTATION (WBS 26.2.02/05)
  - DEVELOP PAYLOAD/STS INTEGRATION CONCEPTS FOR INDIVIDUAL PAYLOADS
  - ESTABLISH ESTIMATED COSTS FOR CANDIDATE INTEGRATION CONCEPTS
  - GENERATE UNIQUE PAYLOAD ICD'S SUPPORTING THE DEVELOPMENT OF PAYLOAD/CARGO INTEGRATION PLANS AND ASSOCIATED ANNEXES
  - ESTABLISH AND IMPLEMENT STS MATH MODELS
  - PAYLOAD INTEGRATION REQUIREMENTS AND SUPPORT
  - DEVELOP, UPDATE, AND MAINTAIN DOCUMENTATION
    - SHUTTLE/CARGO INTERFACE SPECIFICATION (CORE ICD)
    - UNIQUE CARRIER ICD'S
    - CONFIGURATION CONTROL PLANS

ZERO BASE OPERA…ONS COST STUDY

INTEGRATION AND OPERATIONS
PAYLOAD/CARGO INTEGRATION
TASK PERFORMED BY WBS

- CARGO INTERFACE ANALYSIS (WBS 26.2.03)
  - PROVIDE THE TECHNICAL DESIGN AND ANALYSIS TO INTEGRATE A SPECIFIC SET OF PAYLOADS ON AN STS MISSION
    - PAYLOAD/CARGO COMPATIBILITY ASSESSMENT
    - PAYLOAD/CARGO DESIGN
    - PAYLOAD/CARGO INTERFACE DESIGN VERIFICATION
  - PROVIDE DESIGN CENTER LAUNCH SITE SUPPORT (LSS)
  - PROVIDE AND MAINTAIN INTEGRATED HARDWARE LOGISTICS, MAINTENANCE, AND SPARES SYSTEMS
- CARGO INTEGRATION MANAGEMENT (WBS 26.2.06)
  - PROVIDE TECHNICAL MANAGEMENT TO ALL ACTIVITIES
  - PROVIDE PROJECT ENGINEERING TO ALL ACTIVE PAYLOADS
  - PROVIDE BUSINESS MANAGEMENT TO IDENTIFY, SCHEDULE, CONTROL, AND DISSEMINATE CARGO INTEGRATION DATA
- PAYLOAD CARGO INTEGRATION ROM SUPPORT (WBS 26.2.08)
  - PROVIDE ROUGH-ORDER-MAGNITUDE (ROM) PROPOSAL SUPPORT, IN THE AREAS OF MANUFACTURING, MATERIAL/SUBCONTRACTS, PROJECT MANAGEMENT, AND FINANCE AND ADMINISTRATION, FOR CHANGES IN RESPONSE TO NASA/JSC DIRECTION
  - PERFORM HARDWARE ANALYSIS DESIGN CONCEPT STUDIES AND GENERATE PRELIMINARY REQUIREMENTS DOCUMENTS AS REQUIRED

27-Jun-91

ZERO BASE OPERATIONS COST STUDY
SSPO – INTEGRATION AND OPERATIONS
SHUTTLE OPERATIONS MANPOWER FOR STSOC

PROJECT	ELEMENT	PROGRAM FUNDED MANPOWER (MYE'S)									
		1	2	3	4	5	6	7	8	9	10
INTEG OPS	PAYLOAD SAFETY PANEL SPT	1	1	1	1	1	1	1	1	1	1
INTEG OPS	INTEGRATION MANAGEMENT	32	32	32	37	40	43	46	49	52	56
INTEG OPS	CARGO ENGINEERING	12	12	13	15	16	17	19	20	21	22
INTEG OPS	MISSION INTEGRATION	15	15	15	17	20	22	25	27	29	32
	TOTAL	60	60	61	70	77	83	91	97	103	111

ZERO BASE OPERATIONS COST STUDY
STSOC
CONTRACT NAS 9-18000

INTEGRATION MANAGEMENT

- O PREPARES CORRESPONDENCE, CHARTS, DOCUMENTS, MAINTENANCE OF CALENDARS, AND SCHEDULING OF MEETINGS.
- O SUPPORTS CONFIGURATION BASELINING, CONTROL AND MAINTENANCE OF ALL SSP GENERIC, FLIGHT AND PAYLOAD DOCUMENTATION
- O SUPPORTS BASELINING PROCESS FOR PAYLOAD SCHEDULE TEMPLATES AND ASSOCIATED SCHEDULES.
- O SUPPORTS CONFIGURATION MANAGEMENT, MAINTENANCE, AND OPERATIONS OF AUTOMATED MISSION AND PAYLOAD TRACKING SYSTEM (AMPTS)

MISSION INTEGRATION

- O SUPPORTS FLIGHT RATE CAPABILITY ASSESSMENTS AND STS UTILIZATION PLANNING AND MANIFESTING ANALYSES
- O SUPPORTS FLIGHT PRODUCTION SCHEDULING, REVIEW OF CERTAIN PIP ANNEXES AND REAL TIME OPERATIONS

CARGO ENGINEERING

- O SUPPORTS THE DEVELOPMENT BASELINING, CONTROL, MAINTENANCE AND STATUS OF PAYLOAD INTERFACE CONTROL DOCUMENTS (ICD'S), ANNEX 1'S, AND ANNEX 9'S.
- O SUPPORTS THE ASSESSMENT OF PAYLOAD EMI

ZERO BASE OPERATIONS COST STUDY

INTEGRATION AND OPERATIONS
EQUIPMENT/OTHER SUPPORT

- UPPER STAGES SUPPORT
  - TRANSFER ORBITER STAGE (TOS) SUPPORT, UNIQUE WIRING, EVA SUPPORT
- MISSION INTEGRATION SUPPORT
  - TV WORKING GROUP
  - CUSTOMER SUPPORT ROOM
- INTEGRATION MANAGEMENT SUPPORT
  - SOFTWARE ENHANCEMENTS/UPGRADES
  - PRODUCTION HARDWARE SUPPORT

SPECIFIC TO MANAGEMENT INTEGRATION

- SINGLE SHIFT OPERATIONS
- PRCB WILL OPERATE AS NORMAL FOR FLIGHT VEHICLES
- EXISTING INFORMATION SYSTEMS AND PROCESSES WILL REMAIN ACTIVE
- IMPROVEMENTS TO SYSTEM AND PROCESSES WILL CONTINUE TO BE MADE

INTERDEPENDENCIES OF OPERATIONS AND PRODUCTION BUDGETS

- 90.2% OF MANAGEMENT INTEGRATION BUDGET IS OPERATIONS. REMAINING IS PRODUCTION, EQUIPMENT AND SERVICES (FY92, 91-1)
- PRODUCTION FUNDS USED FOR DEVELOPMENT OF NEW INFORMATION SYSTEM AND REPLACEMENT OF OBSOLETE EQUIPMENT

- CONFIGURATION MANAGEMENT
  - RSOC - JSC
  - ROCKWELL SYSTEM INTEGRATION - KSC, MSFC, NASA HEADQUARTERS, AND RI-DOWNEY
- INFORMATION MANAGEMENT
  - RSOC - JSC
  - ROCKWELL SYSTEM INTEGRATION - KSC, MSFC, NASA HEADQUARTERS, AND RI-DOWNEY
- OPERATIONS
  - ROCKWELL SYSTEM INTEGRATION - KSC AND NASA HEADQUARTERS
- EQUIPMENT AND SERVICES

NASA SPACE SHUTTLE PROGRAM MANAGEMENT INTEGRATION OFFICE	SUBJECT: ZERO BASE OPERATIONS METRICS	NAME: DAVID C. SCHULTZ DATE: 5/31/91	PAGE 11A

CONFIGURATION MANAGEMENT

- WORKLOAD ONLY PARTLY RELATED TO FLIGHT RATE, EXAMPLE OF 1990 ACTIVITY:
  - LEVEL II ACTIONS, OPENED 7921, CLOSED 8387
  - CHANGE PACKAGES FOR LEVEL II DOCUMENTS 171
  - PAGES PUBLISHED FOR LEVEL II DOCUMENTS 9792 (11,656 PAGES PUBLISHED IN NO FLIGHT YEAR OF 1987)
  - CHANGES PROCESSED 3246
  - WORK AUTHORIZATION DOCUMENTS (WADS) LOGGED AND REVIEWED 70,000
  - WAD'S MICROFILMED 88,000 PAGES
  - ENGINEERING ORDERS REVIEWED AND ANALYZED 13,000
  - ENGINEERING ISSUES RESOLVED 500
  - TECH ORDERS ANALYZED 1500

ADDITIONAL INFORMATION IN "SUPPORTING DATA".

NASA
SPACE SHUTTLE PROGRAM

MANAGEMENT INTEGRATION OFFICE

SUBJECT:

ZERO BASE OPERATIONS

MANPOWER SUMMARY BY FUNCTION -- FY94

NAME:
DAVID C. SCHULTZ

DATE:
5/31/91

PAGE
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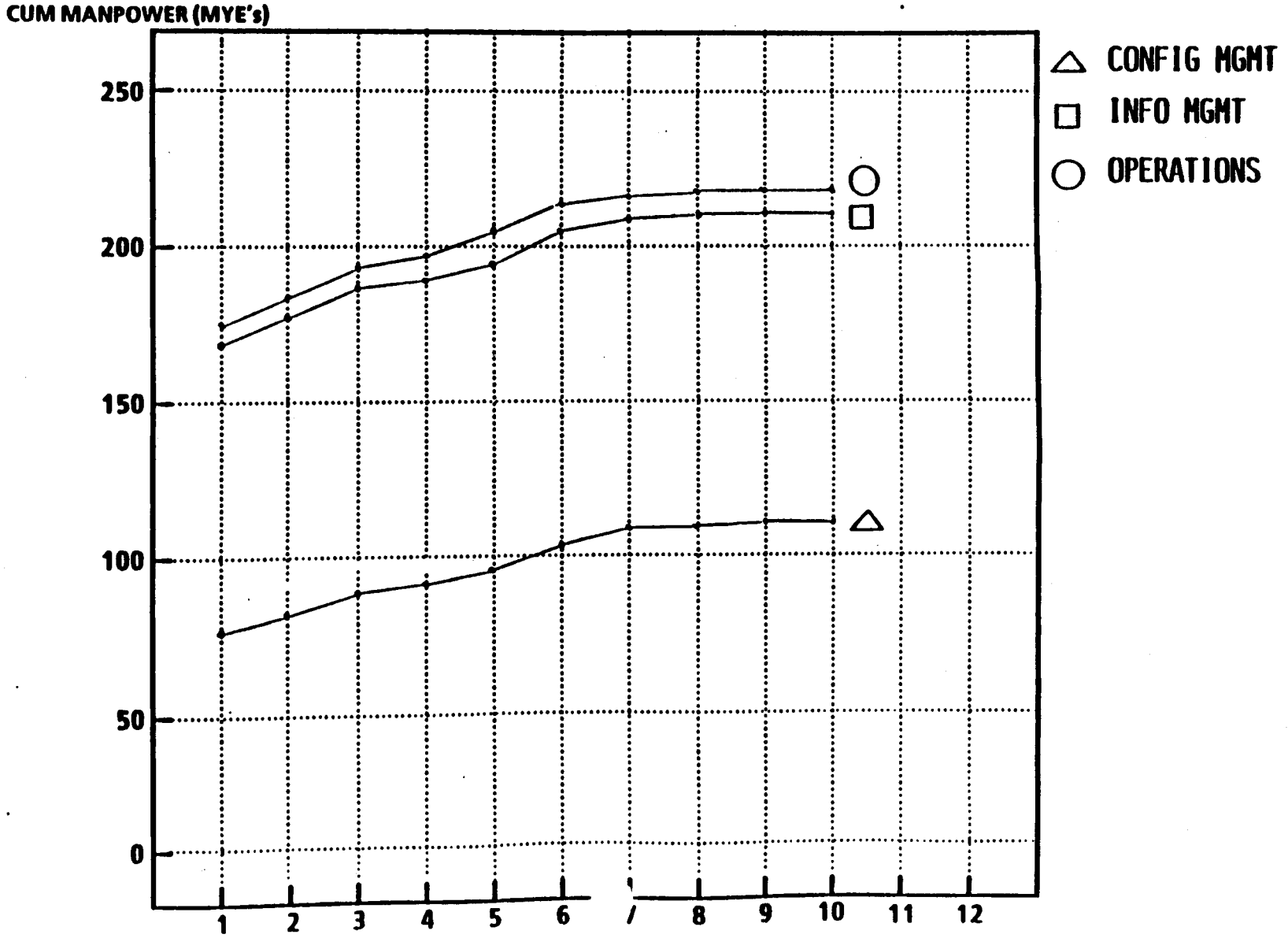


INFORMATION MANAGEMENT

- WORK LOAD NOT RELATED TO FLIGHT RATE BUT TO NUMBER OF INFORMATION SYSTEMS AND NUMBER OF PROGRAM OFFICE AND SUPPORT CONTRACTOR PERSONNEL
  - SEVEN MAJOR COMPUTER SYSTEMS
    - OFFICE AUTOMATION SYSTEM, PROGRAM DOCUMENTATION SYSTEM , ARTEMIS, IMIC, DOCUMENTATION SUPPORT SYSTEM, BARS, OMRS/LCC, XEROX SECRETARIAL SYSTEM
  - FIVE NETWORKS
    - NASANET, NPSS, PSCNI, SSP ETHERNET, ARTEMIS
  - 500 NETWORKED PERSONAL COMPUTERS
  - 500 PROGRAM OFFICE PERSONNEL PERSONNEL SUPPORTED AT FIVE LOCATIONS
  - 1300 CALL FOR ASSISTANCE HANDLED PER MONTH

NASA SPACE SHUTTLE PROGRAM MANAGEMENT INTEGRATION OFFICE	SUBJECT: ZERO BASE OPERATIONS EQUIPMENT AND SERVICES BUDGET	NAME: DAVID C. SCHULTZ	
		DATE: 5/24/91	PAGE 32R

TASK DESCRIPTION

PURPOSE

- FUNDS PURCHASES OF COMPUTER, COMMUNICATIONS AND SOFTWARE FOR SPACE SHUTTLE PROGRAM (G, T, W, AND M) AND LEVEL I (EXAMPLES):
  - SHUTTLE DRAWING SYSTEM (SDS)
  - HARDWARE FOR PROGRAM'S OFFICE AUTOMATION SYSTEM NETWORK AT JSC, KSC, MSFC, NASA HEADQUARTERS AND ROCKWELL-DOWNEY; ROUTERS AND INTERFACE BOXES
  - PERSONAL COMPUTER WORKSTATIONS FOR PROGRAM OFFICE AND SUPPORTING CONTRACTOR PERSONNEL
  - BARS TERMINALS AND PRINTERS
- FUNDS ACQUISITION OF SPECIAL SERVICES (EXAMPLES):
  - SYSTEM ANALYSIS FROM MITRE FOR CONFIGURATION MANAGEMENT SYSTEM IMPROVEMENTS
  - MAINTENANCE CONTRACTS FOR XEROX SECRETARIAL WORKSTATIONS, HIGH SPEED FACSIMILE, DATA BEAM, AND COPY EQUIPMENT
  - LEASE OF SOFTWARE AND MAINTENANCE OF ARTEMIS SCHEDULING SYSTEMS
  - NETWORK ENGINEERING SERVICES FROM JSC INFORMATION SYSTEMS DIRECTORATE
  - LEASE OF NOMAD 2 SOFTWARE FOR TA'S AMPTS

FLIGHT CREW OPERATIONS DIRECTORATE
ZERO BASE OPERATIONS COST STUDY

ZERO BASE OPERATIONS COST STUDY
FLIGHT CREW OPERATIONS DIRECTORATE
GENERAL GROUNDRULES/ASSUMPTIONS

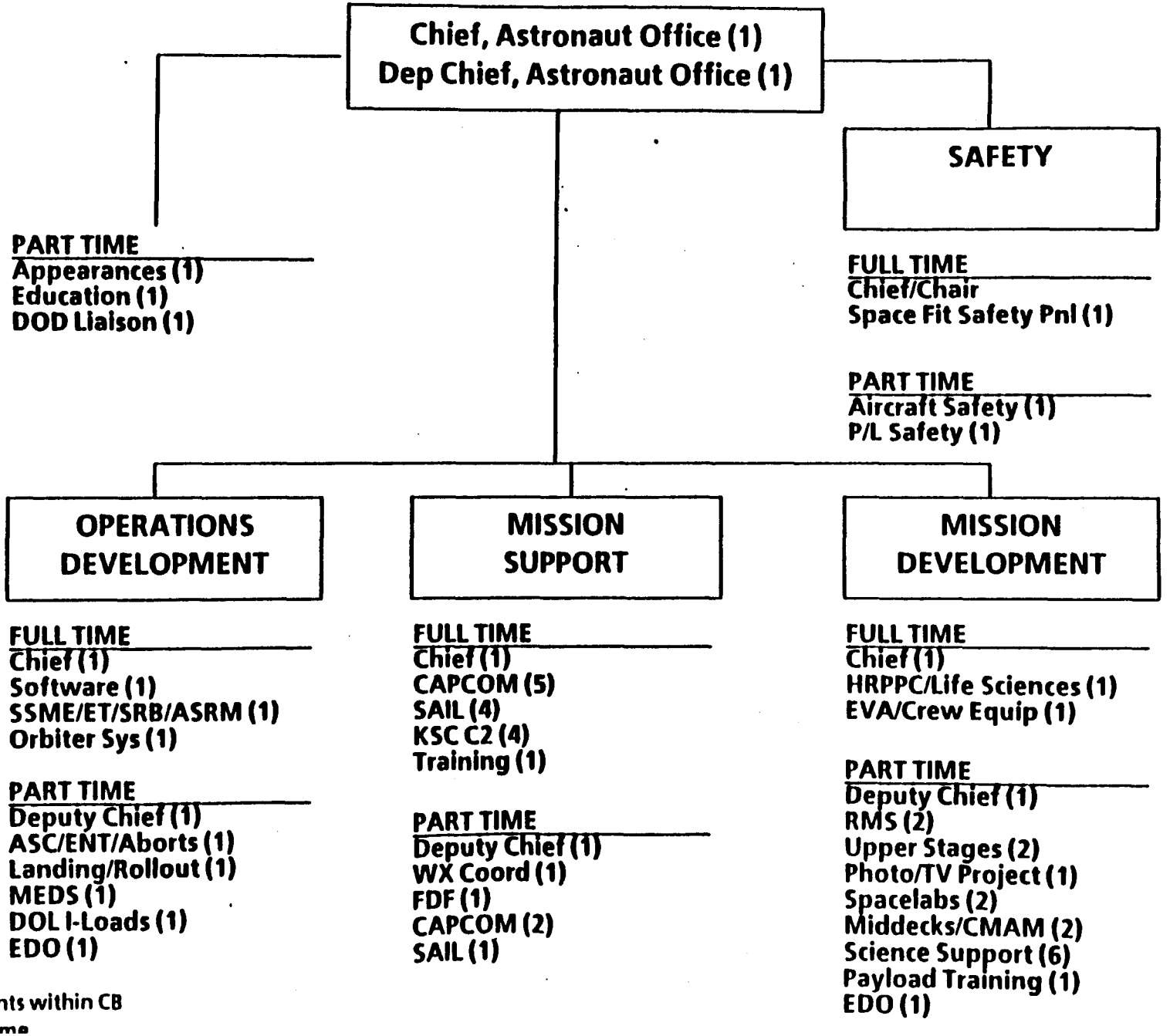
- PROJECT SPECIFIC GROUNDRULES:
  - MINIMUM BASE FOR ASTRONAUT CORPS IS 40 ASTRONAUTS
    - MINIMUM BASE SUPPORTS 1 - 3 FLIGHTS PER YEAR
  - 1 - 4 FLIGHTS PER YEAR/ALL LAND AT DFRF

    5 + FLIGHTS PER YEAR WILL BE 60% DFRF LANDINGS, 40% KSC LANDINGS

FLIGHT CREW OPERATIONS DIRECTORATE
ZERO BASE OPERATIONS COST STUDY
ASTRONAUT ASSUMPTION PROFILES

FLIGHT PROFILE	ASTRONAUT POPULATION	TECHNICAL ASSIGNMENT	CREW ASSIGNMENTS	CMDR/PILOT ASSIGNMENTS
1 - 3	40	20	20	16
4 & 5	60	30	30	25
6 & 7	70	30	40	30
8 - 10	100	40	60	45

ASTRONAUT OFFICE
TECHNICAL ASSIGNMENTS



60 A... gnments within CB
26 Full Time

ZERO BASE OPERATIONS COST STUDY
ASTRONAUT FLIGHT REQUIREMENTS

FLIGHTS/YEAR	1	2	3	4	5	6	7	8	9	10
PRIME	5	12	17	24	29	36	41	48	53	60
EARLY LAB ASSIGN 18 MONTHS		2	2	2	2	4	4	4	4	6
BACKUPS	5	5	5							
TOTAL	10	19	24	26	31	40	45	52	57	66

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ZERO BASE OPEF TIONS COST STUDY
JSC – FLIGHT CREW OPERATIONS DIRECTORATE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE									
		1	2	3	4	5	6	7	8	9	10
FCOD	T-38 M&O	20.2	20.2	20.2	22.8	22.8	24.6	24.6	28.9	28.9	28.9
FCOD	STA M&O	15.3	15.3	15.3	16.4	16.4	17.6	17.6	20.1	20.1	20.1
FCOD	SCA M&O	4.2	4.2	4.2	4.5	4.5	4.5	5.1	5.1	5.1	5.1
FCOD	HAT (HEAVY A/C TRAINING)	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6
FCOD	STSOC SUPPORT	2.7	2.7	2.7	4.1	4.1	4.1	4.1	5.3	5.3	5.3
FCOD	ASTRO OFFICE SUPPORT	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	TOTAL	43.4	43.4	43.4	48.9	48.9	51.9	52.6	60.6	60.6	60.6

ZERO BASE OPERATIONS COST STUDY
FLIGHT CREW OPERATIONS DIRECTORATE
GENERAL GROUNDRULES/ASSUMPTIONS

- PROJECT SPECIFIC GROUNDRULES:
  - T-38 GROUNDRULES
    - ASSUME PILOT PROFICIENCY DEMANDS REMAIN CONSTANT
      - 15 HOURS FLYING TIME PER MONTH PER ASTRONAUT FIRST PILOT
      - 100 HOURS FLYING TIME PER YEAR PER AOD PILOT
    - ASSUME SPARES, POL, AND MAINTENANCE REMAIN A BY-PRODUCT OF HOURS FLOWN
    - ASSUME CURRENT SAFETY CRITERIA REMAIN UNCHANGED

ZERO BASE OPERATIONS COST STUDY

FLIGHT CREW OPERATIONS DIRECTORATE

GENERAL GROUND RULES/ASSUMPTIONS

- PROJECT SPECIFIC GROUND RULES, CONTINUED:
  - STA GROUND RULES
    - ASSUME ONE ADDITIONAL STA IS NEEDED FOR DOWN-TIME MAINTENANCE TO PROVIDE STA LEVEL NEEDED FOR FLIGHT RATE
    - ASSUME SPARES, POL, AND MAINTENANCE REMAIN A BY-PRODUCT OF HOURS FLOWN
    - ASSUME CURRENT SAFETY CRITERIA REMAIN UNCHANGED.
  - SCA GROUND RULES
    - ASSUME TWO AIRCRAFT: ONE MISSION READY, ONE FLYABLE STORAGE
      - ONE FERRY MISSION PER DFRF LANDING
      - ONE MAINTENANCE CONTINUATION FLIGHT EACH NON-FERRY MONTH FOR THE MISSION READY AIRCRAFT
      - 12 MAINTENANCE CONTINUATION FLIGHTS PER YEAR FOR THE FLYABLE STORAGE AIRCRAFT.
    - ASSUME SPARES, POL, AND MAINTENANCE REMAIN A BY-PRODUCT OF HOURS FLOWN
    - ASSUME CURRENT SAFETY CRITERIA REMAIN UNCHANGED.

ZERO BASE OPERATIONS COST STUDY

FLIGHT CREW OPERATIONS DIRECTORATE

GENERAL GROUND RULES/ASSUMPTIONS

- PROJECT SPECIFIC GROUND RULES, (CONTINUED):
  - ASSUME ONE SCA MAINTAINED AT EDWARDS/ONE MAINTAINED AT EL PASO (NATIONAL RESOURCES ACT).
  - ASSUME AGENCY WILL MEET ALL BOEING AGING FLEET REQUIREMENTS FOR BOTH AIRCRAFT
  - ASSUME SERVICE BULLETIN WORK WILL BE PERFORMED UNDER 5-YEAR FLEET SERVICE CONTRACT.
- HAT
  - ASSUME RATIO OF LAUNCH RELATED USAGE REMAINS CONSTANT
    - THREE HAT FLIGHTS FOR INITIAL ASTRONAUT TRAINING
    - ONE HAT FLIGHT PER ASSIGNED CREW MEMBER PRIOR TO LAUNCH

FLIGHT CREW OPERATIONS DIRECTORATE

ZERO BASE OPERATIONS COST STUDY

MAJOR DRIVERS TO FLIGHT RATE BASE AND INCREMENTS

FLTS/YR	RATIONALE
1-3 (BASE)	• BASE ASTRONAUT CORPS SIZE (40 CIVIL SERVANT/MILITARY)
	• AOD PILOT CADRE REQUIRED TO SUPPORT BASE PROGRAM REQUIREMENTS (19 PILOTS)
4-5	• AIRCRAFT M&O AND STSOC SUPPORT BASED ON INCREASE IN ASTRONAUT CORPS (20 CIVIL SERVANT/MILITARY)
	• AIRCRAFT M&O INCREASE TO AOD PILOT CADRE
6-7	• AIRCRAFT M&O BASED ON INCREASE IN ASTRONAUT CORPS (10 CIVIL SERVANT/ MILITARY)
8-10	• AIRCRAFT M&O AND STSOC SUPPORT BASED ON INCREASE IN ASTRONAUT CORPS (30 CIVIL SERVANT/MILITARY)
	• AIRCRAFT M&O BASED ON INCREASE TO AOD PILOT

JSC - ENGINEERING DIRECTORATE
ZERO BASE OPERATIONS COST STUDY

ZERO BASED OPERATIONS COST STUDY APPROACH

- A GRASS ROOTS ASSESSMENT BASED ON HISTORICAL DATA
  - DEFINED SHUTTLE RELATED PRODUCTS/RESPONSIBILITIES
  - ESTABLISHED GROUNDRULES AND ASSUMPTIONS
  - DETERMINED MYE/FACILITY RELATIVE TO:
    - DELIVERED PRODUCTS
    - SUPPORTING THE MANIFESTED FLIGHT RATE
  - DETERMINED TOTAL OPERATIONAL COST BASED ON:
    - MYE's
    - MATERIALS
  - EXAMINED ALL TASK ORDERS FUNDED IN PRODUCTION AND OPERATIONS TO DETERMINE TRUE OPERATIONS CONTENT IN EACH
  - COMPARED RESOURCE REQUIREMENTS TO POP 91-1 SUBMITTAL
    - RECONCILED DIFFERENCES

ZERO BASE OPERATIONS COST STUDY

JSC - ENGINEERING DIRECTORATE

GROUNDRULES AND ASSUMPTIONS

- INSTITUTIONAL SUPPORT WILL CONTINUE AT APPROVED LEVELS
- SUPPORT SHARED AMONG PROGRAMS, PROJECT, AND INSTITUTION WILL CONTINUE
- FLIGHT REMANIFESTING WILL BE CONSISTENT WITH PAST EXPERIENCE
- OPERATIONAL EFFORTS CONSIDERS ALL ACTIVITIES FROM LAUNCH THROUGH VEHICLE TURNAROUND
- ALL CURRENTLY APPROVED OPERATIONS REQUIREMENTS WILL REMAIN INTACT
- EXISTING FACILITIES CAPABILITY WILL BE MAINTAINED

ZERO BASE OPERATIONS COST STUDY

JSC - ENGINEERING DIRECTORATE

DIVISION DESCRIPTION

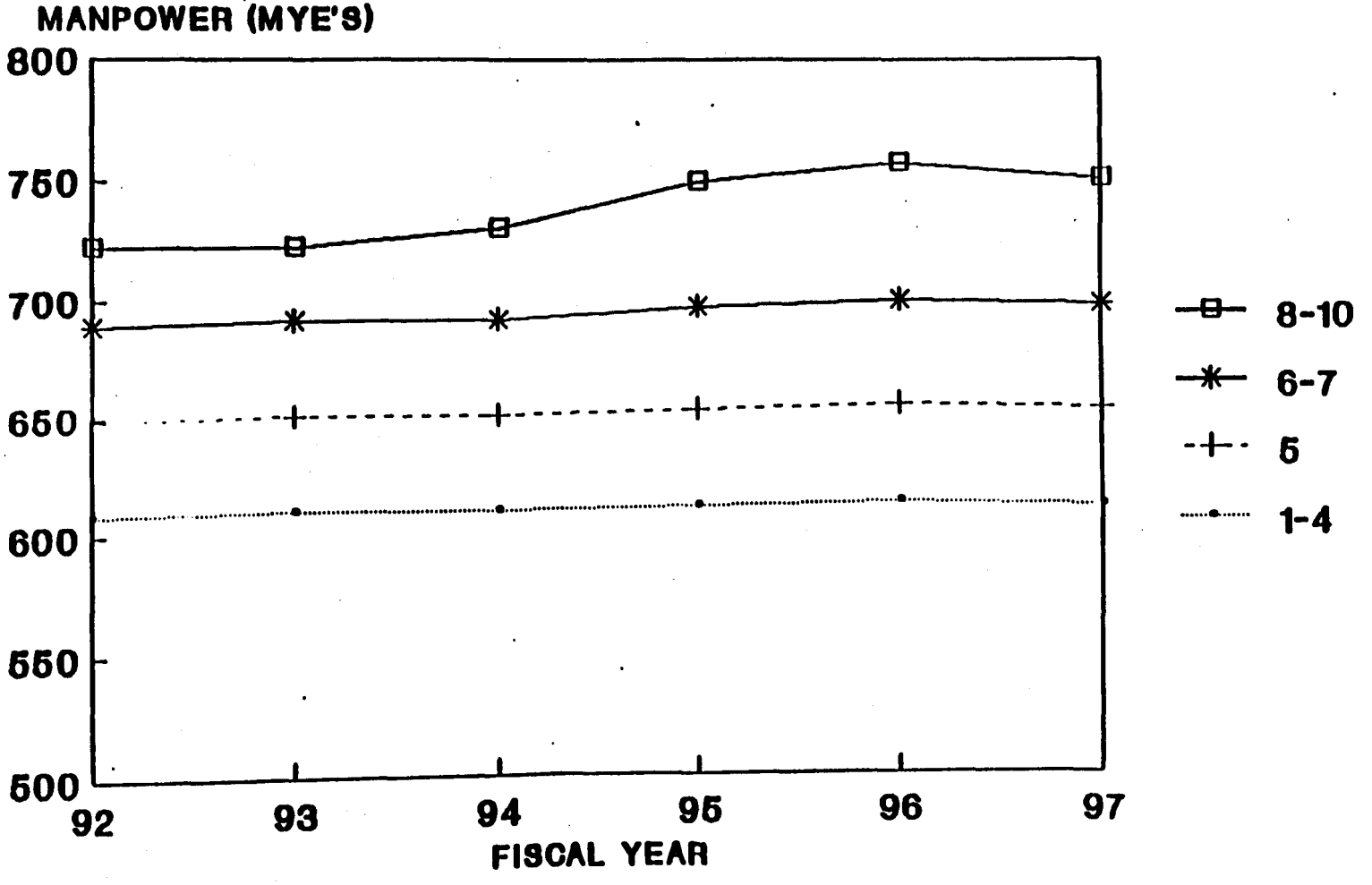
- FLIGHT DATA SYSTEM (EK)
  - FLIGHT SOFTWARE
  - SUBSYSTEMS - DATA PROCESSING, DISPLAYS & CONTROLS, RECORDERS & INSTRUMENTATION
- NAVIGATION, CONTROL & AERONAUTICS (EG)
  - FLIGHT SOFTWARE - GN&C REQUIREMENTS
  - FLIGHT PERFORMANCE - ASCENT & ENTRY AERO
  - SUBSYSTEMS - NAVIGATION, CONTROLS & GUIDANCE
- CREW & THERMAL SYSTEM (EC)
  - CREW TRAINING - THERMAL VACUUM
  - SUBSYSTEMS - LIFE SUPPORT ACTIVE THERMAL CONTROL, ATMOSPHERIC REVITALIZATION, AND GFE CREW EQUIPMENT
- SYSTEM ENGINERING (ET)
  - CREW TRAINING - SES/RMS
  - PAYLOADS INTEGRATION

27-Jul

ZERO BASE OPER TIONS COST STUDY
JSC – ENGINEERING DIRECTORATE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	10
ENG	FLIGHT DATA SYSTEMS	50.2	50.2	50.2	51.1	52.5	53.6	53.7	54.2	54.4	54.6
ENG	NAV. CONTROL & AERO	6.9	6.9	6.9	6.9	8.9	9.2	9.2	10.6	10.6	10.6
ENG	CREW & THERMAL	6.2	6.4	6.6	6.9	7.1	7.6	7.8	8.1	8.2	8.4
ENG	SYSTEMS ENGINEERING	3.6	3.6	4.0	4.4	4.9	4.9	4.9	5.0	5.0	5.0
ENG	STRUCTURES & MECHANICS	1.9	2.2	2.5	2.8	3.1	3.3	3.6	3.7	4.1	4.3
ENG	TRACKING & COMMUNICATION	2.2	2.2	2.2	2.2	2.3	2.9	3.0	3.1	3.4	3.4
ENG	PROPULSION & POWER	2.1	2.1	2.1	2.1	2.1	2.6	2.6	2.6	2.7	2.7
ENG	AUTOMATION & ROBOTICS	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ENG	MANAGEMENT SUPPORT	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
	TOTAL	76.8	77.3	78.2	80.1	84.6	87.8	88.5	91.0	92.1	92.7

ZERO BASE OPERATIONS COST STUDY
JSC - ENGINEERING DIRECTORATE
MANPOWER SUMMARY



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ZERO BASED OPERATION COST STUDY
JSC - ENGINEERING DIRECTORATE
DIVISION DESCRIPTION (CON'T.)

- STRUCTURES & MECHANICS (ES)
  - LOADS & DYNAMICS INTEGRATION
  - PAYLOADS INTEGRATION
  - SUBSYSTEMS - STRUCTURES, PASSIVE THERMAL CONTROL, ACTUATION SYSTEM, LANDING GEAR AND MATERIALS

- COMMUNICATION AND TRACKING (EE)
  - ELECTRO MAGNETIC EFFECTS
  - SUBSYSTEMS - S-BAND, KU-BAND, ANTENNAS, TELEVISION AND TAGS

- PROPULSION AND POWER (EP)
  - PROPULSION SYSTEM INTEGRATION
  - SUBSYSTEMS - MPS, OMS/RCS, APU/HYDRAULICS, FUEL CELLS/PRSD, BATTERIES, PYRO, EPDC AND HAZARD GAS

- AUTOMATION AND ROBOTICS (ER)
  - SRMS HARDWARE/SOFTWARE

ZERO BASE OPERATIONS COST STUDY

JSC - ENGINEERING DIRECTORATE

MAJOR DRIVERS TO THE MINIMUM BASE

FLIGHTS/YR	RATIONALE
BASE (1 THROUGH 4)	• MINIMUM CRITICAL SKILLS AND ENGINEERING BASE CAPABILITY • FLIGHT DATA SYSTEM - SUPPORTS FLIGHT SOFTWARE BUILD, CERTIFICATION AND TEST FACILITIES SUPPORT FOR ONE OI RELEASE PER YEAR • NAVIGATION, CONTROL, AND AERO - SUBSYSTEM MANAGER AND PRINCIPAL FUNCTION MANAGER SUPPORT, FLIGHT SOFTWARE REQUIREMENTS DEFINITION AND ASSESSMENTS, ISL TEST SUPPORT AND MISSION SUPPORT • CREW AND THERMAL SYSTEMS - EVA CREW TRAINING SUPPORT IN VARIOUS CHAMBER FACILITIES AND SUBSYSTEM MANAGER SUPPORT • SYSTEM ENGINEERING - SUPPORTS CREW TRAINING WITH ONE-SHIFT OPERATION OF SES • STRUCTURES AND MECHANICS - PROVIDE BASIC STRUCTURAL LOADS, DYNAMICS, THERMAL, AND MATERIAL MISSION SUPPORT - PRINCIPALLY PAYLOAD ANALYSES • COMMUNICATION AND TRACKING - PROVIDES BASIC MISSION/ SUBSYSTEM MANAGER SUPPORT • PROPULSION AND POWER - PROVIDES BASIC MISSION/SUBSYSTEM MANAGER SUPPORT • AUTOMATION AND ROBOTICS - PROVIDES BASIC MISSION/SUBSYSTEM MANAGER SUPPORT

ZERO BASE OPERATIONS COST STUDY

JSC - ENGINEERING DIRECTORATE

MAJOR DRIVERS TO FLIGHT RATE INCREMENTS

FLIGHTS/YR	RATIONALE
5	• FLIGHT DATA SYSTEMS - EXCEEDS BASE CAPABILITY TO SUPPORT FLIGHT SOFTWARE CERTIFICATION • NAVIGATION, CONTROLS, AND AERO - ADDITIONAL SUBSYSTEM MANAGER AND PRINCIPAL FUNCTION MANAGER SUPPORT, ADDITIONAL SUPPORT FOR ASCENT/ENTRY SES AND SAIL TEST SPONSOR SUPPORT • SYSTEM ENGINEERING - REQUIRES SECOND-SHIFT OPERATION TO SUPPORT SES CREW TRAINING
6-7	• FLIGHT DATA SYSTEMS - EXCEEDS BASE CAPABILITY TO SUPPORT FLIGHT SOFTWARE TEST FACILITIES AND OPERATIONS • NAVIGATION, CONTROLS, AND AERO - REQUIRES SECOND-SHIFT OPERATIONS TO SUPPORT ISL • COMMUNICATIONS AND TRACKING - EXCEEDS BASIC CAPABILITY TO PROVIDE MISSION ANALYSIS AND FLIGHT SUPPORT • PROPULSION AND POWER - EXCEEDS BASE CAPABILITY TO PROVIDE MISSION ANALYSIS AND FLIGHT SUPPORT • CREW AND THERMAL SYSTEMS - REQUIRES ADDITIONAL STAFFING TO SUPPORT INCREASE IN CREW TRAINING

ZERO BASE OPERATIONS COST STUDY

JSC - ENGINEERING DIRECTORATE

MAJOR DRIVERS TO FLIGHT RATE INCREMENTS (CONT'D)

FLIGHTS/YR	RATIONALE
8/9/10	• FLIGHT DATA SYSTEMS - ADDITIONAL FLIGHT SOFTWARE MANPOWER FOR CERTIFICATION OF FLIGHT-TO-FLIGHT SOFTWARE RECONFIGURATION, AND FOR TRAINING/TEST OPERATIONS • NAVIGATION CONTROLS AND AERO - ADDITIONAL SUBSYSTEM MANAGER AND PRINCIPAL FUNCTION MANAGER SUPPORT, ADDITIONAL SUPPORT FOR SAIL TEST SPONSORS

KSC PAYLOAD OPERATIONS
ZERO BASE OPERATIONS COST STUDY

PAYLOAD OPERATIONS

ZERO BASED OPERATIONS STUDY

DEFINITIONS:

VERTICAL PAYLOADS - GENERALLY ARRIVES AT KSC PPF'S FOR FINAL FACTORY CHECKOUT, THEN TO VPF FOR CITE AND IVT, AND INSTALLED AT THE PAD (ORBITER VERTICAL). GENERALLY CONTAINS HAZARDOUS FUELS. FUNDED WITH UPN 570 FROM VPF ON.

HORIZONTAL PAYLOADS - GENERALLY BUILT-UP WITH EXPERIMENTS ON PAYLOAD CARRIERS - SPACELAB, PALLETS, MPESS, ETC IN O&C, THEN CITE TEST AND IVT PRIOR TO INSTALLATION IN THE ORBITER (HORIZONTAL) AT THE OPF. FUNDED WITH UPN 926 (SPACELAB OPERATIONS); CITE TEST AND TRANSFER TO PAD IS FUNDED WITH UPN 570.

NOTE: THERE IS A SIGNIFICANT MANPOWER DIFFERENCE IN PAYLOAD OPERATIONS (UPN 570) BETWEEN PAYLOADS WHICH ARE PROCESSED THROUGH THE VPF AND THOSE WHICH ARE PROCESSED THROUGH THE O&C.

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ZERO BASE OPE ATIONS COST STUDY
KSC – PAYLOAD OPERATIONS
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE									
		1	2	3	4	5	6	7	8	9	1
P/L OPS	VERTICAL P/L MISSION DIRECT	2.8	2.8	5.3	5.3	5.5	7.7	8.1	8.3	10.5	11.
P/L OPS	MISSION RELATED SUPPORT	3.4	3.4	5.4	6.5	7.6	8.0	8.0	8.0	8.0	8.
P/L OPS	OFF-LINE P/L SUPPORT	3.5	3.5	5.9	7.9	8.2	9.0	9.1	9.2	9.6	9.
P/L OPS	SUSTAINING ENGINEERING	0.0	0.0	2.5	3.4	3.6	4.6	4.6	4.6	4.6	4.
P/L OPS	GROUND SYS DEVELOPMENT - DE	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.
P/L OPS	EMC/AECOMM/RASCOMM	1.0	1.0	1.2	1.2	1.2	2.0	2.0	2.0	2.0	2.
P/L OPS	PAYLOAD DATA PROCESSING	0.4	0.4	0.8	1.2	1.3	1.5	1.5	1.5	1.5	1.
P/L OPS	MANAGEMENT	0.3	0.3	0.7	0.9	1.1	1.2	1.2	1.2	1.2	1.
P/L OPS	TOTAL PGOC	11.4	11.4	21.8	26.4	28.5	34.3	34.8	35.1	37.7	38.
P/L OPS	SUPPORT	2.8	2.9	3.4	3.5	3.7	3.9	4.1	4.5	4.6	5.
	TOTAL	14.2	14.3	25.2	29.9	32.2	38.2	38.9	39.6	42.3	43.

NOTE: NOT A GENERIC TABLE – NOT BASED ON POP 91-1 BUDGET MANIFEST. THE FLIGHT MIX IS AS FOLLOWS:

FLIGHT #1 – TDRS
FLIGHT #2 – SPACELAB
FLIGHT #3 – TDRS
FLIGHT #4 – SPACELAB
FLIGHT #5 – SPACELAB
FLIGHT #6 – TDRS
FLIGHT #7 – SPACELAB
FLIGHT #8 – SPACELAB
FLIGHT # 9 – TDRS
FLIGHT #10 – SPACELAB

ZERO BASE OPERA. ONS COST STUDY

PAYLOAD OPERATIONS

PGOC MANPOWER

MINIMUM CAPABILITY

ASSUMPTIONS AND GROUNDRULES - BY FLIGHT INCREMENT

o 1 TO 2 FLIGHTS PER YEAR (1 VERTICAL)
- OPERATE AND MAINTAIN ONLY 1 CELL IN VPF
- OPERATE AND MAINTAIN 1 PAYLOAD CANISTER
- NO CANISTER ROTATION FACILITY (USE VAB FOR ROTATION)
- INTERFACE VERIFICATION TESTING TO BE PERFORMED IN THE ORBITER
- NO CITE EQUIPMENT MAINTENANCE
- LSOC WOULD PROVIDE TRANSPORTER OPERATIONS USING PGOC'S TRANSPORTER #2 FOR PAYLOAD CANISTER AND SRB STACKING
- PAD OPERATIONS WOULD BE STRETCHED TO 10 WEEKS FROM THE STANDARD 6 WEEK FLOW

o 3 FLIGHTS PER YEAR (2 VERTICAL)
- PGOC WOULD OPERATE AND MAINTAIN 1 TRANSPORTER AND PROVIDE PAYLOAD CANISTER TRANSPORTATION
  - -- AT 3 FLIGHTS PER YEAR PAYLOAD OPERATIONS REQUIRE USE OF A TRANSPORTER DURING EACH OF 6 MONTHS PER YEAR. THEREFORE, TO AVOID SCHEDULE IMPACTS, PAYLOAD OPERATIONS WILL REQUIRE A DEDICATED TRANSPORTER.
- INTERFACE VERIFICATION TESTING TO BE PERFORMED IN CITE TO MITIGATE SCHEDULE RISK TO STS
- STANDARD 6 WEEK PAD OPERATIONS FLOW
  - -- AT 3 FLIGHTS PER YEAR, PAD TIME IS REDUCED BACK TO STANDARD FLOW TO SUPPORT ORBITER SCHEDULE REQUIREMENTS

o 4 FLIGHTS PER YEAR (2 VERTICAL)
- OPERATE AND MAINTAIN 2 CANISTERS AND 1 TRANSPORTER
  - -- AT 4 FLIGHTS, CONCURRENT VERTICAL AND HORIZONTAL ACTIVITIES OCCUR; THEREFORE A CANISTER OF EACH CONFIGURATION IS REQUIRED

o 5 FLIGHTS PER YEAR (2 VERTICAL)
- OPERATE AND MAINTAIN CANISTER ROTATION FACILITY TO MITIGATE SCHEDULE PROBLEMS IN THE VAB
- OPERATE AND MANTAIN 2 CANISTER AND 2 TRANSPORTERS
  - -- AT 5 FLIGHTS PER YEAR, CONCURRENT VERTICAL AND HORIZONTAL TRANSPORTATION ACTIVITIES OCCUR; THEREFORE TWO TRANSPORTERS ARE REQUIRED

o 6 FLIGHTS PER YEAR (3 VERTICAL)
- OPERATE AND MAINTAIN 2 CELLS IN VPF TO MITIGATE SCHEDULE RISK TO PAYLOAD OPERATIONS
- FIXED BASE CAPABILITY REACHED (SUPPORT WBSs CAPABLE OF SURGING TO 10 FLIGHTS PER YEAR)

ZERO BASE OPERATIONS COST STUDY
PAYLOAD OPERATIONS
FACILITY UTILIZATION

	FLIGHT RATE									
FACILITY	1	2	3	4	5	6	7	8	9	10
VPF CELLS	1	1	1	1	1	2	2	2	2	2
CANNISTERS	1	1	1	2	2	2	2	2	2	2
TRANSPORTERS	-*	-*	1	1	2	2	2	2	2	2
CANNISTER ROTATION FACILITY	-	-	-	-	1	1	1	1	1	1
CITE CONTROL ROOM AND 2 MECHANICAL	-	-	2	2	2	2	2	2	2	2

*TRANSPORTER SHARED WITH SPC FOR PAYLOAD AND SRB TRANSPORTATION

ZERO BASE OPERATIONS COST STUDY

PAYLOAD PROCESSING

PAYLOAD GROUND OPERATIONS MANPOWER BY ELEMENT - FY94 IN MYE'S

ELEMENT	FLIGHT RATE									
	1	2	3	4	5	6	7	8	9	10
VERTICAL PAYLOADS MISSION DIRECT	42	42	80	80	83	116	122	125	158	167
MISSION RELATED SUPPORT	51	51	82	98	115	121	121	121	121	121
OFF-LINE PAYLOAD SUPPORT	25	25	43	63	64	65	65	65	65	65
SUSTAINING ENGINEERING	0	0	31	42	46	58	58	58	58	58
GROUND SYSTEMS DEVELOPMENT - DE	0	0	0	0	0	4	4	4	4	4
EMC/AECOMM/RASCOMM	15	15	18	18	18	30	30	30	30	30
PAYLOAD DATA PROCESSING	6	6	12	18	19	22	22	22	22	22
MANAGEMENT	5	5	10	14	16	18	18	18	18	18
TOTAL PGOC	144	144	276	333	361	434	440	443	476	485

NOTE: NOT A GENERIC TABLE - NOT BASED ON POP 91-1 BUDGET MANIFEST. THE FLIGHT MIX IS AS FOLLOWS:

FLIGHT #1 - TDRS
FLIGHT #2 - SPACELAB
FLIGHT #3 - TDRS
FLIGHT #4 - SPACELAB
FLIGHT #5 - SPACELAB
FLIGHT #6 - TDRS
FLIGHT #7 - SPACELAB
FLIGHT #8 - SPACELAB
FLIGHT #9 - TDRS
FLIGHT #10 - SPACELAB

ZERO BASE OPERATIONS COST STUDY

PAYLOAD MANAGEMENT AND OPERATIONS DIRECTORATE

KENNEDY SPACE CENTER

- THE FLOW TIME FOR PAD OPERATIONS WAS EXTENDED.
- THIS ANALYSIS YIELDED THE FOLLOWING PROCESSING FLOW:

	MONTH											VPF	PAD				
ACTIVITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	MM	
MISS PLAN	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4					70.6	
PROCED. AND S/W				8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6					68.7	
MISS MGMT										1.3	3.9	3.9	2.6	2.6	2.6	16.9	
VPF OPS										20.0	20.0	20.0				60.1	
PAD OPS												23.5	35.5	35.0		94.0	← PEAK
POST MISS.															8.1	8.1	
MONTHLY MM	6.4	6.4	6.4	15.0	15.0	15.0	15.0	15.0	15.0	36.3	38.9	47.4	38.1	37.6	10.7	318.4	
												↑ PEAK					

- PROCESSING FLOW IS FIVE MONTHS.
- "PEAK" MANPOWER WAS REDUCED FROM 74.4 MM TO 47.4 MM.

ZERO BASE OPE TIONS COST STUDY
PAYLOAD OPERATIONS
PGOC MANPOWER
MINIMUM CAPABILITY

WBS		1 FLIGHT/YR 1 MAJOR VERTICAL PAYLOAD IN FLOW	3 FLIGHTS/YR 2 MAJOR VERTICAL PAYLOADS/ 1 SPACELAB IN FLOW	6 FLIGHTS/YR 3 MAJOR VERTICAL PAYLOADS/ 3 SPACELABS IN FLOW	9 FLIGHTS/YR 4 MAJOR VERTICAL PAYLOADS/ 5 SPACELABS IN FLOW
5.1	VERTICAL PAYLOADS MISSION DIRECT FLIGHT HARDWARE PROCESSING OF ALL VERTICAL PAYLOADS. TRANSPORTATION TO THE OPF/ PAD FOR ALL SHUTTLE PAYLOADS	42 (PEAK - 46 MM) (SKILL RETEN. - 15)	80 (PEAK - 114 MM) (SKILL RETEN. - 24)	116 (PEAK - 155 MM)	158 (PEAK - 216 MM)
5.2	MISSION RELATED SUPPORT MANIFEST ANALYSIS, SCHEDULING, WK CONTROL, SE&I, NON-MISSION SR&QA, & GROUND SYSTEM SUPPORT FOR ALL VERTICAL FACILITIES/GSE	51	82	121	121
5.3	OFFLINE PAYLOAD SUPPORT LOGISTICS & OFFLINE SUPPORT (I.E., CALIBRATION, REPAIR, WAREHOUSING, JANITORIAL, ETC.)	25	43	65	65
5.4	SUSTAINING ENGINEERING ENGINEERING MODIFICATIONS FOR VERTICAL FACILITIES AND EQUIPMENT	0	31	58	58
5.5	GROUND SYSTEMS DEVELOPMENT - DE DESIGN ENGINEERING FOR VERTICAL GROUND SYS.	0	0	4	4
5.6	EMC/AECOMM/RASCOMM EMC AND COMMUNICATIONS SUPPORT FOR TESTING AND OPERATIONS	15	18	30	30
5.7	MANAGEMENT PAYLOAD OPERATIONS PROJECT MGMT., PROJECT CONTROL, FISCAL REPORTING	5	10	18	18
5.8	PAYLOAD DATA PROCESSING COMPUTER SERVICES	6	12	22	22
	TOTAL MANPOWER	44	276	434	476

MSFC SPACE SHUTTLE SYSTEMS
ZERO BASE OPERATIONS COST STUDY

28-Jun-91

ZERO BASE OPERATIONS COST STUDY
MSFC – PROPULSION SYSTEMS INTEGRATION
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE									
		1	2	3	4	5	6	7	8	9	10
PSI	I&PS	10.3	11.2	11.6	11.6	11.6	12.6	13.0	13.0	13.0	13.0
PSI	- HOSC OPERATIONS	3.2	3.7	4.1	4.1	4.1	5.0	5.2	5.2	5.2	5.2
PSI	- DATA REDUCTIONS	2.8	3.2	3.2	3.2	3.2	3.3	3.5	3.5	3.5	3.5
PSI	- CENTER-WIDE ADP	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
PSI	- OTHER *	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
PSI	SYSTEMS INTEG SUPPORT	9.2	9.2	9.2	10.8	10.8	10.8	11.5	11.5	11.5	11.5
PSI	GENERAL SHUTTLE **	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PSI	S&E SUPPORT	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
PSI	ADMINISTRATIVE OPERATIONS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	TOTAL	24.8	25.7	26.1	27.7	27.7	28.7	29.8	29.8	29.8	29.8

* COMMON COMMUNICATIONS SUPPORT (OTHER THAN HOSC COMMUNICATIONS)
** SMALL BUSINESS & MISCELLANEOUS PROCUREMENTS

ZERO BASE OPERATIONS COST STUDY
MSFC PROPULSION SYSTEMS INTEGRATION

ELEMENT DESCRIPTIONS

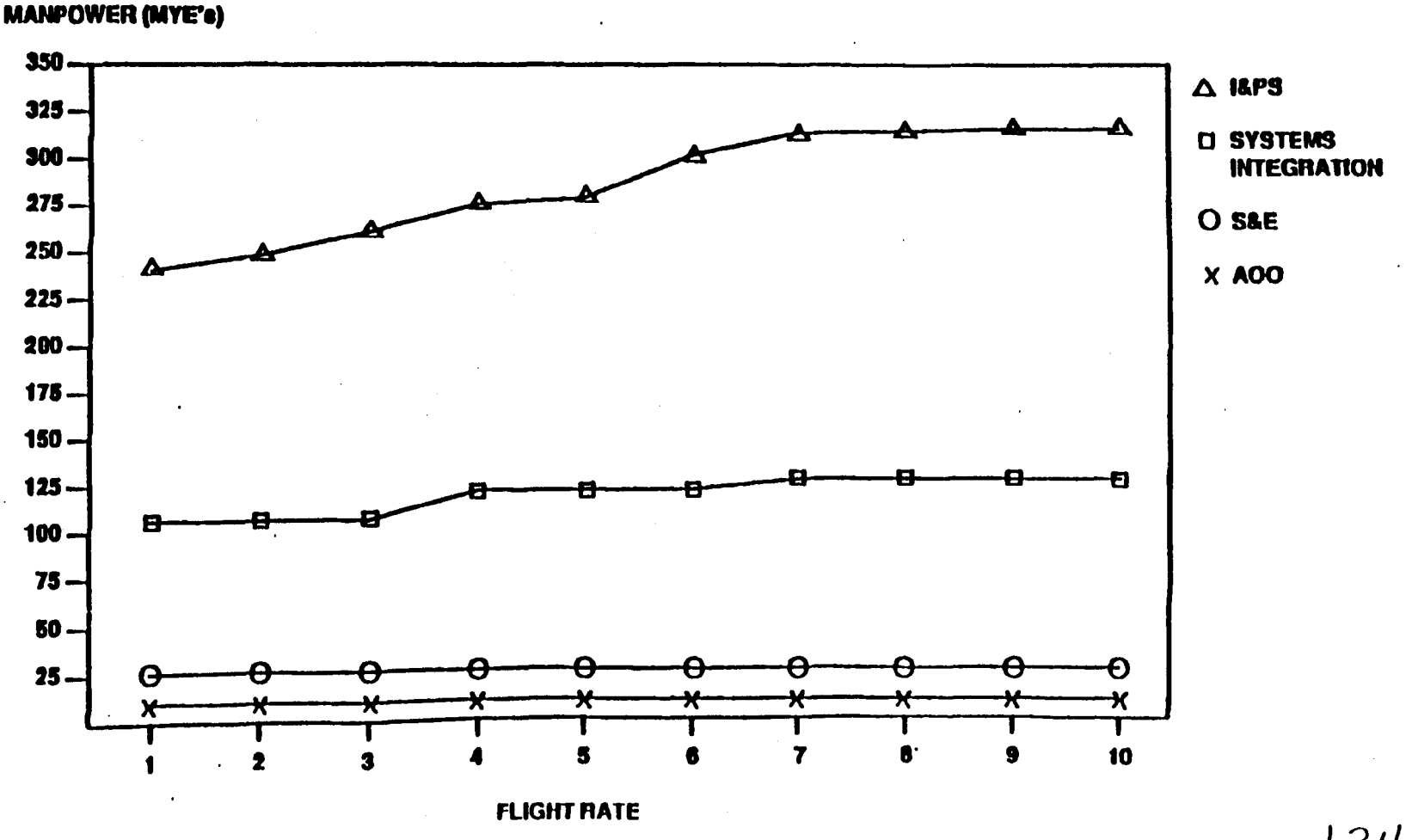
- **INSTITUTIONAL & PROGRAM SUPPORT (I&PS)**
  - HOSC OPERATIONS
    - ADP SUPPORT
    - COMMUNICATIONS
  - SHUTTLE PROJECTS CENTER-WIDE ADP SUPPORT
  - DATA REDUCTION CENTER
    - ADP SUPPORT
    - COMMUNICATIONS

- **S&E SUPPORT**
  - TECHNICAL STUDIES
  - WEATHER SUPPORT

- **SYSTEMS INTEGRATION SUPPORT**
  - SCHEDULES & LOGISTICS
  - PERFORMANCE ANALYSIS
  - REQUIREMENTS, DEVELOPMENT & VERIFICATION
  - CHANGE EVALUATION & MANAGEMENT
  - INFORMATION MANAGEMENT SYSTEM

ZERO BASE OPERATIONS COST STUDY
MSFC SPACE SHUTTLE SYSTEMS

MANPOWER SUMMARY BY ELEMENT



ZERO BASE OPERATIONS COST STUDY
MSFC PROPULSION SYSTEMS INTEGRATION

MAJOR DRIVERS TO THE MINIMUM BASE

- **CRITICAL SKILLS**
  - **HOSC OPERATIONS**
  - **DATA REDUCTION**
  - **MSFC SHUTTLE INTEGRATION SUPPORT**
  - **S&E TECHNICAL STUDIES/WEATHER SUPPORT**
  - **ADP SUPPORT TO SHUTTLE PROJECTS (CENTER - WIDE)**

ZERO BASE OPERATIONS COST STUDY

MSFC PROPULSION OPERATIONS COST STUDY

MAJOR DRIVERS TO FLIGHT RATE INCREMENTS

FLIGHTS/YR	RATIONALE
2-3	• CRITICAL SKILLS LEVEL FOR HOSC OPERATIONS
4-5	• CRITICAL SKILLS FOR SYSTEMS INTEGRATION SUPPORT TO FLIGHT AND POST-FLIGHT EVALUATION ACTIVITIES (OMI/OMRS/LCC/HOSC/SCHEDULES)
6	• CRITICAL SKILLS LEVEL FOR HOSC OPERATIONS AND DATA REDUCTION
7-10	• CRITICAL SKILLS LEVEL FOR HOSC OPERATIONS, DATA REDUCTION EFFORT AND SHUTTLE INTEGRATION SUPPORT TO FLIGHT OPERATIONS AND POST-FLIGHT EVALUATION

SPACE AND LIFE SCIENCES DIRECTORATE
ZERO BASE OPERATIONS COST STUDY

ZERO BASE OPE' \TIONS COST STUDY
JSC – SPACE AND LIFE SCIENCES DIRECTORATE
SHUTTLE OPERATIONS COSTS BY ELEMENT -- FY 94 IN RY $

PROJECT	ELEMENT	FLIGHT RATE ($)									
		1	2	3	4	5	6	7	8	9	10
S & LSD	MOCKUPS & TRAINERS	6.0	7.8	7.8	7.8	7.8	9.6	9.6	9.6	9.6	10.8
S & LSD	EQ STOWAGE & INTEG ENG	1.5	1.5	1.5	1.5	1.5	1.8	1.9	1.9	1.9	1.9
S & LSD	MED OPS CLINICAL LAB SUPPORT	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
S & LSD	TOXICOLOGY & MICROB LAB OPS	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
S & LSD	SHUTTLE MEDICAL OPS	1.2	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4
S & LSD	CREW HEALTH SUPPORT	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
S & LSD	EARTH IMAGE VIEWING	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
S & LSD	SHUTTLE CAMERA SPT	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
S & LSD	SIMULATOR SUPPORT	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
S & LSD	GFE DESIGN/FLT CREW EQ	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
S & LSD	DECAL & NOMENCLAT PLACARDS	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
S & LSD	STS FLIGHT MEDICINE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
S & LSD	THERMAL & METABOLIC LAB	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
S & LSD	RADIATION ANALYSIS SPT	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
S & LSD	PAYLOADS & ENG ANALYSIS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
S & LSD	SHUTTLE MEDICAL INF SYS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S & LSD	FOOD PROVISIONING	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S & LSD	FABRICATION & TEST SPT	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S & LSD	STS RADIATION DOSIMETRY SPT	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S & LSD	CARDIOVASCUALR LAB	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S & LSD	SHUTTLE PHOTO & TV ANALYSIS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
S & LSD	SONIC BOOM MEASURE & MODEL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
S & LSD	ANTHROPOMETRIC & BIOMECH SPT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	TOTAL	18.9	20.8	20.8	20.8	20.8	22.9	23.1	23.1	23.1	24.3

ZERO BASE OPERATIONS COST STUDY

SPACE AND LIFE SCIENCES DIRECTORATE

ELEMENT DESCRIPTIONS

MOCKUPS AND TRAINERS

- PROVIDE AND OPERATE SHUTTLE MOCKUPS, TRAINERS, AND TRAINING LOOSE EQUIPMENT TO SUPPORT ENGINEERING EVALUATIONS AND FLIGHT CREW TRAINING.

EQUIPMENT STOWAGE (CCCD) AND INTEGRATION ENGINEERING

- PROVIDE CCCD FOR EACH STS FLIGHT, ANNEX 6 AND ICD FOR EACH PIP, AND CREW COMPARTMENT INTEGRATION ENGINEER FOR EACH SHUTTLE FLIGHT.

MEDICAL OPERATIONS CLINICAL LABORATORY SUPPORT

- PROVIDE TOTAL ANALYTICAL SUPPORT TO THE SHUTTLE MEDICAL OPERATIONS PROGRAM IN THE AREAS OF CLINICAL CHEMISTRY, HEMATOLOGY, HUMORAL IMMUNOLOGY, CLINICAL ENDOCRINOLOGY AND BIOCHEMISTRY.

TOXICOLOGY AND MICROBIOLOGY LABORATORY OPERATIONS

- PROVIDE ANALYTICAL AND TECHNICAL SUPPORT OF GROUND BASED AND INFLIGHT OPERATIONAL AND DEVELOPMENTAL EFFORTS TO ENSURE A TOXICOLOGICALLY SAFE INFLIGHT ENVIRONMENT FOR CREWMEMBERS.

SHUTTLE MEDICAL OPERATIONS

- PROVIDE MEDICAL OPERATIONS SUPPORT FOR SHUTTLE MISSIONS IN THE MCC AND AT LAUNCH, LANDING, AUGMENTED, AND EMERGENCY LANDING SITES: INCLUDED PLANNING, DOCUMENTATION, AND ANALYSIS.

ZERO BASE OPERATIONS COST STUDY

SPACE AND LIFE SCIENCES DIRECTORATE

ELEMENT DESCRIPTIONS (CONT'D)

CREW HEALTH SUPPORT

- PROVIDE CREW HEALTH STABILIZATION AND MISSION CONTROL CENTER CLINICAL SUPPORT FOR EACH SHUTTLE MISSION AND CONTINUING MEDICAL SUPPORT TO MANNED CHAMBER AND WETF TESTS.

EARTH IMAGE VIEWING

- EARTH OBSERVATIONS CREW TRAINING AND REAL TIME SUPPORT IS NECESSARY IN ORDER TO PROVIDE REQUIRED SUPPORT TO SECONDARY PAYLOADS, DOD EARTH ORIENTED EXPERIMENTS, ADVANCED CAMERA/SENSOR EVALUATIONS, AND SCIENTIFICALLY SIGNIFICANT PHOTOGRAPHY AND OBS OF THE EARTH.

SHUTTLE CAMERA SUPPORT

- ESTABLISH REQUIREMENTS FOR ALL CAMERA SYSTEMS; PUBLISH FLIGHT DOCUMENTATION OF FLIGHT HARDWARE REQUIREMENTS. PROVIDE R&D AND APPLICATION ENGINEERING. PROVIDE ENGINEERING SUPPORT TO MODIFY EXISTING HARDWARE. SUPPORT SPECIAL HARDWARE REQUIREMENTS. SUPPLY ALL PHOTOGRAPHIC HARDWARE NOT CONSIDERED STANDARD OPERATIONAL.

SIMULATOR SUPPORT

- SIMULATOR SPECIAL INSTRUMENTS MAINTENANCE, MAINTAIN ADEQUATE SPARES LEVELS.

GFE DESIGN/FLIGHT CREW EQUIPMENT

- PROVIDE ENGINEERING DESIGN AND TECHNICAL CORE SUPPORT FOR ADEQUATE AND CONTINUOUS SUBSYSTEM MANAGEMENT CAPABILITIES FOR CREW EQUIPMENT SUBSYSTEMS.

ZERO BASE OPERATIONS COST STUDY

SPACE AND LIFE SCIENCES DIRECTORATE

ELEMENT DESCRIPTIONS (CONT'D)

DECAL AND NOMENCLATURE PLACARDS

- PROVISIONING USING MULTIPLE PROCESSES (I.E., SCREEN PRINTING, PHOTO-REPRODUCTION, AND MANUAL).

STS FLIGHT MEDICINE

- PROVIDE CREW MEDICAL OFFICER MATERIALS, FLIGHT SURGEON TRAINING SUPPORT, PREVENTIVE MEDICINE SUPPORT, MEDICAL RECORDS ADMINISTRATION, AND REPORT GENERATION.

THERMAL AND METABOLIC OPERATIONAL SUPPORT LABORATORY

- PROVIDE ASSESSMENT OF PHYSIOLOGIC ACCEPTABILITY OF ENVIRONMENTAL FACTORS CONTROLLED BY SUIT AND CABIN ECS, SPECIFICALLY, HEAT BALANCE PARAMETERS, GAS PRESSURE AND COMPOSITION, AND ASSESSMENT OF O_2 UTILIZATION (METABOLIC RATE).

SPACE SHUTTLE RADIATION ANALYSIS SUPPORT

- PROVIDE ANALYSES OF IONIZING RADIATION EFFECTS TO THE SPACE SHUTTLE CREW AND EQUIPMENT.

PAYLOADS ENGINEERING ANALYSIS

- PROVIDE SUPPORT FOR SHUTTLE DESIGN CHANGE AND PAYLOAD INTEGRATION VIA PLAID COMPUTER GRAPHIC; DEFINE CCTV CAMERA REQUIREMENTS FOR SHUTTLE FLIGHT; PROVIDE CREW VISUAL ACCESS ANALYSIS; PERFORM SIMPLE LIGHTING STUDIES; ASSESS CREW TASKS AND MAN-MACHINE INTERFACES; PROVIDED REAL-TIME MISSION SUPPORT.

ZERO BASE OPERA..ONS COST STUDY

SPACE AND LIFE SCIENCES DIRECTORATE

ELEMENT DESCRIPTIONS (CONT'D)

SHUTTLE MEDICAL INFORMATION SYSTEM

- PROVIDE LIFE SCIENCES COMPUTER SUPPORT FOR MEDICAL OPERATIONS AND BIOMEDICAL LABORATORIES.

FOOD PROVISIONING

- TASK TO PROVIDE A CURRENT SHUTTLE FOOD SYSTEM AND DOCUMENTATION, AND TO PROVIDE RESEARCH AND DEVELOPMENT ACTIVITIES FOR THE SHUTTLE FOOD SYSTEM.

FABRICATION AND TEST SUPPORT

- PROVIDE MATERIALS TESTING AT WSTF, FABRICATION OF PROTOTYPES, EMI TESTING, EQUIPMENT TESTING, AND COMPONENT PURCHASES.

STS RADIATION DOSIMETRY SUPPORT

- PROVIDE HARDWARE AND SERVICES TO MEET STS MEDICAL AND OPERATIONAL SUPPORT REQUIREMENTS FOR RADIATION EXPOSURE MEASUREMENTS.

CARDIOVASCULAR LABORATORY

- SUPPORT THE SHUTTLE PROGRAM BY DOCUMENTING CARDIOVASCULAR ADAPTATIONS TO SPACEFLIGHT AND SUBSEQUENT POSTFLIGHT READAPTATION, AND PROVIDE GUIDELINES FOR THE MAINTENANCE OF APPROPRIATE CARDIOVASCULAR FITNESS OF SPACEFLIGHT CREWMEMBERS. ALSO, DEVELOP PHARMACOLOGICAL, MECHANICAL, AND BEHAVIORAL COUNTERMEASURES AS APPROPRIATE.

ZERO BASE OPERATIONS COST STUDY

SPACE AND LIFE SCIENCES DIRECTORATE

ELEMENT DESCRIPTIONS (CONT'D)

SPACE SHUTTLE PHOTO & TV ANALYSIS: CONTINGENCY READINESS

- CONTINGENCY PLANS (NSTS 08218, JSC 14273, AND JSC 22853) CALL FOR IMAGE ANALYSIS AND ENHANCEMENT EFFORTS WITHIN THE AGENCY TO BE AUGMENTED AND MAINTAINED AT JSC TO ENSURE ADEQUATE CAPABILITIES IN THE EVENT OF A CONTINGENCY.

SONIC BOOM MEASUREMENTS AND MODELING

- PROVIDE SUPPORT TO NASA LEGAL OFFICE FOR SONIC BOOM MEASUREMENTS AND MODELING.

ANTHROPOMETRIC AND BIOMECHANIC SUPPORT

- PROVIDE SUPPORT FOR SHUTTLE MISSIONS VIA MEASUREMENT OF PHYSICAL PERFORMANCE CAPABILITIES OF SUITED AND UNSUITED CREWMEMBERS.

SPECIAL TOPICS

- MARGINAL COSTS FOR ADDING OR SUBTRACTING ONE FLIGHT
- POTENTIAL BUDGET TRANSFERS BETWEEN OPERATIONS AND PRODUCTION

ZERO BASE OPERATIONS COST STUDY

ADDITION OR DELETION OF 1 LAUNCH FROM STEADY STATE RATE

- **ASSUMPTIONS**
  - AT LEAST 2 YEAR NOTIFICATION
  - AVERAGE COMPLEXITY MISSION
  - USED FY94 AS REPRESENTATIVE YEAR FOR ± 1 FLIGHT

ZERO BASE OPERATIONS COST STUDY
VARIABLE COST VERSES MARGINAL COST
FOR A FY94 FLIGHT

FLIGHT/YEAR	TOTAL COST	VARIABLE COST	MARGINAL COST ADD A FLIGHT	MARGINAL COST DELETE A FLIGHT
1	2024.1			
		52.9	65.1	-37.7
2	2077.0			
		87.0	63.3	-39.1
3	2164.0			
		209.1	191.6 *	-41.4
4	2373.1			
		143.5	95.6	-56.6
5	2516.6			
		132.9	90.5	-56.9
6	2649.5			
		224.2	181.4 *	-57.1
7	2873.7			
		140.7	106.3	-57.3
8	3014.4			
		104.4	75.4	-57.5
9	3118.8			
		86.5	71.2	-57.8
10	3205.3			

* - DRIVEN BY KSC LAUNCH AND LANDING

NOTE: ASSUMES 4 ET'S PER YEAR MINIMUM BUILD
AND 3 FLIGHTS PER YEAR MINIMUM SSME SUPPORT

MARGINAL COST . I FLIGHT
1 FLIGHT ADDED IN FY94 – RY$
(FROM 9 TO 10)

PROJECT	SINGLE FLT MARGINAL COST	MARGINAL COST CONTENT
MSFC		
SSME	5.2	REFURB TOUCH LABOR, PRODUCT INSPECTION, HARDWARE MATERIAL
SRB	9.8	PROD TOUCH LABOR, INSPECTION, VENDOR REPAIRS, EXPENDABLE & ATTRITION HARDWARE
RSRM	14.6	TOUCH LABOR AND EXPENDABLE MATERIAL
ET	14.0	TOUCH LABOR, INSPECTION, FLIGHT HARDWARE
JSC		
MOD	1.2	STSOC MISSION PLANNING, FLT READINESS ASSESSMENT, FLT EXECUTION, POST FLT ACTIVITIES
ENG	0.5	CREW TRAINING AND FAMILIARIZATION, DIRECT MISSION SUPPORT ACTIVITIES, FLT HARDWARE TEST & CERT, SYSTEMS PERFORMANCE VERIFICATION
ORBITER	1.8	
	0.3	OPS SUPPORT & LAUNCH SITE SUPPORT
	0.3	FEPC CONSUMABLES
	0.9	ET DISCONNECTS
	0.3	RMS OVERHAUL & REPAIR
FCOD	0.5	FLT OPS OF ORBITER FERRY, KC-135 PATHFINDER, STA TRAINING: ASSUMES LANDING AT DFRC

MARGINAL COST . . (FLIGHT
1 FLIGHT ADDED IN FY94 – RY$
(FROM 9 TO 10)

PROJECT	SINGLE FLT MARGINAL COST	MARGINAL COST CONTENT
KSC		
LOGISTICS OPERATIONS	3.7	REPLENISHMENT SPARES & OVERHAUL AND REPAIRS
LAUNCH & LANDING	16.1	
PROPELLANTS		ONBOARD PROPELLANTS
SPC		FREIGHT & TRAVEL FOR ALTERNATE LANDING SITES
BOC		PROPELLANT HANDLING M/P ABOVE CORE
LSS		RANGE SUPPORT, CLS XENON LIGHTS, SLS SUPPORT AT EAF PHOTO SUPPORT
P/L OPERATIONS	0.2	TRANSPORTATION TO THE PAD: ASSUMES P/L OF OPPORTUNITY OR DOD P/L IS DELETED
SSPO		
INTEG & OPS	1.1	CARGO INTERFACE DOCUMENTATION, ENGINEERING ASSURANCE AND CARGO INTEG MGMT
OPS INTEG	0.2	DDMS INCLUDING RANGE SPT FOR EACH LAUNCH ATTEMPT
ENGINEERING INTEG	2.3	MISSION CONFIG REQMTS, MASS PROP/TRAJ DESIGN DATA PACK, ASCENT FLT DESIGN, FLT MARGINS ASSESS, LSEAT & MISSIONS SPT, POST FLT ANAYSIS, FLT S/W INTEG, OMRS/LCC
TOTAL $M	71.2	

SSME
ZERO BASE OPERATIONS COST STUDY

ADDITION OF ONE FLIGHT IN FY94

FLIGHT RATE	FY94	FY95	FY96	FY97	TOTAL
3	.8	2.7	4.4	7.9	15.8
4	.3	.9	1.4	2.6	5.2
5	.3	.9	1.5	2.6	5.3
6	.4	1.4	2.3	4.1	8.2
7	.3	.9	1.4	2.6	5.2
8	.4	1.2	1.9	3.5	7.0
9	.3	.9	1.4	2.6	5.2
10					

SRB PROJECT
ZERO BASE OPERATIONS COST STUDY

(S IN MILLIONS)

FY94 FLIGHT ADDED (BUDGET INCREASE)							
BASE RATE	FY93	FY94	FY95	FY96	FY97	FY98 +	TOTAL
1/YR						7.0	7.0
2	0.6	0.3	1.0			7.0	8.9
3	0.6	0.6	1.0			7.0	9.1
4	0.5	0.7	1.1			7.0	9.2
5	0.5	0.7	1.3		1.1	5.8	9.4
6	0.3	0.8	1.4	0.3	1.8	4.8	9.5
7	0.3	0.8	1.5	0.6	2.1	4.3	9.6
8	0.2	0.9	1.6	0.6	2.5	4.0	9.8
9	0.2	0.7	1.7	0.6	2.9	3.8	9.8
10	0.1	1.0	1.7	0.6	3.4	3.4	10.3

RSRM PROJECT
ZERO BASE OPERATIONS COST STUDY

($ IN MILLIONS)

FY94 FLIGHT ADDED (BUDGET INCREASE)			
BASE RATE	FY93	FY94	TOTAL
1/YR			
2		9.8	9.8
3		9.8	9.8
4		9.8	9.8
5		9.8	9.8
6		9.8	9.8
7	3.5	11.1	14.6
8	3.5	11.1	14.6
9	3.5	11.1	14.6
10	3.5	11.1	14.6

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EXTERNAL TANK
ZERO BASE COST STUDY

COSTS (FY91 $M)

PRODUCTION RATE:	4/YR	5/YR	6/YR	7/YR	8/YR	9/YR	10/YR
	$350M	$364M	$379M	$396M	$413M	$428M	$442M
BETWEEN PROD. RATES:		$14M	$15M	$17M	$17M	$15M	$14M

COST DISTRIBUTION

- EACH PRODUCTION RATE HAS A UNIQUE COST DISTRIBUTION. "LOOK-BACK" COSTS ARE EFFECTED BY FLIGHT HARDWARE PROCUREMENT, SHIFTING ASSUMPTIONS, AND FLOW TIME.

MARGINAL COST PER FLIGI
1 FLT OUT OF FY94 – RY$

PROJECT	SINGLE FLT MARGINAL COST*	MARGINAL COST CONTENT
MSFC		
SSME	1.8	REFURB TOUCH LABOR, PRODUCT INSPECTION, HARDWARE MATERIAL
SRB	10.3	PROD TOUCH LABOR, INSPECTION, VENDOR REPAIRS, EXPENDABLE & ATTRITION HARDWARE
RSRM	14.6	TOUCH LABOR AND EXPENDABLE MATERIAL
ET	15.0	TOUCH LABOR, INSPECTION, FLIGHT HARDWARE
JSC		
MOD	1.2	STSOC MISSION PLANNING, FLT READINESS ASSESSMENT, FLT EXECUTION, POST FLT ACTIVITIES
ENG	0.5	CREW TRAINING AND FAMILIARIZATION, DIRECT MISSION SUPPORT ACTIVITIES, FLT HARDWARE TEST & CERT, SYSTEMS PERFORMANCE VERIFICATION
ORBITER	1.8	
	0.3	OPS SUPPORT & LAUNCH SITE SUPPORT
	0.3	FEPC CONSUMABLES
	0.9	ET DISCONNECTS
	0.3	RMS OVERHAUL & REPAIR
FCOD	0.5	FLT OPS OF ORBITER FERRY, KC-135 PATHFINDER, STA TRAINING; ASSUMES LANDING AT DFRC

* THESE REDUCTIONS ARE APPLICABLE AT ALL FLIGHT RATES EXCEPT FOR SRB AND RSRM

MARGINAL COST PER FLIGHT
1 FLT OUT OF FY94 – RY

PROJECT	SINGLE FLT MARGINAL COST*	MARGINAL COST CONTENT
KSC		
LOGISTICS OPERATIONS	3.7	REPLENISHMENT SPARES & OVERHAUL AND REPAIRS
PROPELLANTS	1.1	ONBOARD PROPELLANTS
SPC	0.7	FREIGHT & TRAVEL FOR ALTERNATE LANDING SITES
BOC	0.1	PROPELLANT HANDLING M/P ABOVE CORE
LSS	2.7	RANGE SUPPORT, CLS XENON LIGHTS, SLS SUPPORT AT EAFB, PHOTO SUPPORT
P/L OPERATIONS	0.2	TRANSPORTATION TO THE PAD; ASSUMES P/L OF OPPORTUNITY OR DOD P/L IS DELETED
SSP		
INTEG & OPS	1.1	CARGO INTERFACE DOCUMENTATION, ENGINEERING ASSURANCE AND CARGO INTEG MGMT
OPS INTEG	0.2	DDMS INCLUDING RANGE SPT FOR EACH LAUNCH ATTEMPT
ENGINEERING INTEG	2.3	MISSION CONFIG REQMTS, MASS PROP/TRAJ DESIGN DATA PACK, ASCENT FLT DESIGN, FLT MARGINS ASSESS, LSEAT & MISSIONS SPT, POST FLT ANALYSIS, FLT S/W INTEG, OMRS/LCC
TOTAL $M	57.8	

* THE REDUCTIONS ARE APPLICABLE AT ALL FLIGHT RATES EXCEPT FOR SRB AND RSRM

SRB PROJECT
ZERO BASE OPERATIONS COST STUDY

($ IN MILLIONS)

FY94 FLIGHT DELETED (SAVINGS)						
BASE RATE	FY94	FY95	FY96	FY97	FY98 +	TOTAL
1/YR					7.0	7.0
2					7.0	7.0
3	0.6	0.9			7.0	8.4
4	0.6	1.0		0.3	7.0	8.9
5	0.7	1.1		1.1	6.2	9.1
6	0.8	1.3	0.3	1.8	5.1	9.4
7	0.9	1.4	0.6	2.1	4.7	9.6
8	1.0	1.5	0.6	2.5	4.2	9.8
9	1.1	1.9	0.6	2.9	3.5	10.0
10	1.3	1.7	0.6	3.4	3.3	10.3

RSRM PROJECT
ZERO BASE OPERATIONS COST STUDY

($ IN MILLIONS)

FY94 FLIGHT DELETED (BUDGET DECREASE)			
BASE RATE	FY93	FY94	TOTAL
1/YR			
2		-9.8	-9.8
3		-9.8	-9.8
4		-9.8	-9.8
5		-9.8	-9.8
6		-9.8	-9.8
7	-3.5	-11.1	-14.6
8	-3.5	-11.1	-14.6
9	-3.5	-11.1	-14.6
10	-3.5	-11.1	-14.6

ZERO BASE OPERATIONS COST STUDY

KSC LAUNCH AND LANDING

- **COST FOR ADDITIONAL MISSION**
  - COST AT NEXT HIGHER INCREMENTAL LAUNCH RATE FOR 1 1/4 YEARS
  - 12 MONTHS OF "OPERATION" AT NEXT HIGHER LEVEL
  - 3 MONTHS PENALTY COST (INCLUDES HIRING, TRAINING, CERTIFICATION OF PERSONNEL, TERMINATION OF PERSONNEL, ABILITY TO ADD MISSION)
  - CONTINGENT UPON AVAILABILITY OF ORBITERS, FACILITIES & GSE, IMPLEMENTATION OF NEW SHIFTING REQUIREMENTS, ETC.

BASE RATE	FY94
1/YR	32.0
2	28.3
3	140.6
4	41.4
5	34.7
6	120.6
7	48.4
8	17.5
9	16.1
10	

DEFINITION OF TERMS

- **DEVELOPMENT (PRODUCTION)**

  ALL ACTIVITIES INVOLVED IN ATTAINING AND IMPLEMENTING THE INITIAL CAPABILITY OF A SYSTEM PLUS THE EFFORTS ASSOCIATED WITH SUBSEQUENT ENHANCING/UPGRADING. THIS ACTIVITY SHOULD INCLUDE, BUT NOT BE LIMITED TO, THE DESIGN, FABRICATION, TEST, AND CERTIFICATION OF NEW OR MODIFIED HARDWARE, E.G., IMPROVED APU, CCTV, EDO, ETC. THIS ACTIVITY SHOULD INCLUDE MAJOR HARDWARE REDESIGN EFFORTS THAT HAVE BEEN INITIATED TO CORRECT FAILURES ON SYSTEMS THAT OCCURRED DURING ATP, GROUND TEST, FLIGHT OPERATIONS, ETC.

- **OPERATIONS**

  ALL ACTIVITIES INVOLVED IN THE DAY-TO-DAY REPETITIVE EFFORTS REQUIRED TO INSURE A SYSTEM CAN ROUTINELY PERFORM ITS FUNCTION/MISSION. SUSTAINING ENGINEERING IS CONSIDERED TO BE A SUBSET OF OPERATIONS, AND INCLUDES ALL ACTIVITIES ASSOCIATED WITH GROUND TURNAROUND, PRELAUNCH, FLIGHT, AND POST LANDING SUPPORT.

  - EXAMPLES OF SUSTAINING ENGINEERING ACTIVITIES:

    - GROUND TURNAROUND - WAIVERS, EXCEPTIONS, RCN EVALUATIONS, PROBLEM ANALYSIS, BUT NOT REDESIGN, ETC.

    - PRELAUNCH - COFR ACTIVITIES, I-LOADS VERIFICATION, LCC REVIEWS, ETC.

    - FLIGHT - MISSION SUPPORT, IFA ANALYSIS, FILE IX ASSESSMENT, MISSION REPORT, ETC.

SUSTAINING ENGINEERING IS BASICALLY A SYSTEM EVALUATION/ASSESSMENT ACTIVITY AND DOES NOT INCLUDE MAJOR DESIGN, FABRICATION OR TEST.

SPACE SHUTTLE POP 91-2 BUDGET RECOMMEND CANDIDATES FOR PRODUCTION TRANSFERS TO OPERATIONS NOA RY M$

PROJECT	PURPOSE	FY92	FY93	FY94	FY95	FY96	FY97	RECOM'D XFER
CURRENT PROPOSED CHANGES								
RSRM	TOOLING	2.1	0.8	3.6	0.8	4.1	4.1	YES
RSRM	PROJECT SUPPORT	6.3	6.1	6.2	5.3	5.3	5.4	YES
SSME	TEST SUPPORT	TBD	TBD	TBD	TBD	TBD	TBD	NO
SSME	INST AND PROGRAM SUPPORT	6.8	7.1	7.3	7.6	7.9	8.3	YES
ENG INTG	PCASS	5.4	5.2	5.0	4.9	4.7	4.5	YES
ENG INTG	IMIC	4.6	4.8	5.0	5.1	5.3	5.5	YES
ENG INTG	SYSTEMS INTEG	1.4						YES
ENG INTG	AVIONICS SYSTEMS ENG	1.1	1.2	1.2	1.3	1.3	1.4	YES
OPS INTG	LANDING SUTE/SPARES	2.5	0.8	0.7	0.5	0.3	0.3	YES
OPS INTG	LAKEBED STATUS	0.2	0.2	0.2	0.2	0.2	0.2	YES
OPS INTG	MISSION SUPPORT	0.4	0.4	0.4	0.5	0.5	0.5	YES
MGMT INT	EQ & SERVICES (ADP, COMM & INFO MGMT SYSTEMS)	2.5	1.6	1.7	1.6	1.6	1.7	YES
ENG	FLIGHT DATA SYSTEMS (ORB DATA SYS SPT – RECONFIG DATA REV & VERIFICATION)	1.0	1.0	1.1	1.1	1.2	1.2	YES
ENG	NAV CONTROL AND AERONAUTICS (MISSION TO MISSION SPT: SUBSYSTEM MGMT., SAIL TEST, SES TEST, I-LOAD SELECTION AND DEFINITION)	6.5	6.8	7.1	7.5	7.8	8.1	YES
ENG	SYSTEMS ENGINEERING (SES SPT: ON-ORBIT TRAINING & PROCEDURE DEVELOPMENT)	2.7	2.9	3.0	3.1	3.3	3.4	YES
ENG	STRUCTURES & MECHANICS (ORBITER AERO EVALUATION)	0.1	0.1	0.1	0.1	0.1	0.1	YES
ENG	TRACKING & COMMUNICATIONS (SUBSYS MGMT SPT: ANALYSIS, GFE, MSBLS, CCTV)	1.7	1.8	1.9	2.0	2.0	2.1	YES
ENG	CREW & THERMAL SYSTEMS (ECLSS SUBSYSTEM MANAGEMENT SUPPORT)	0.3	0.3	0.4	0.4	0.4	0.4	YES
ENG	PROPULSION & POWER (SUBSYSTEM MGMT SPT: PREFLIGHT ACTIVITIES, REAL-TIME MISSION SUPPORT, DATA ANALYSES)	1.7	1.7	1.8	1.9	2.0	2.1	YES
ENG	PROPULSION & POWER (GFE PYROTECHNICS)	0.3	0.3	0.3	0.3	0.3	0.3	YES
MOD	MCC UPGRADE	5.0	5.2	5.5	5.7	6.0	6.2	YES
TOTAL		52.6	48.3	52.5	49.9	54.3	55.8	

SPACE SHUTTLE POP 91-2 BUDGET RECOMMEND CANDIDATES FOR OPERATIONS TRANSFERS TO PRODUCTION NOA RY M$

PROJECT	PURPOSE	FY92	FY93	FY94	FY95	FY96	FY97	RECOM'D XFER
CURRENT PROPOSED CHANGES								
ENG INTEG	DEVELOPMENT FOR FLIGHT OPS	6.3	2.3	2.7	2.8	3.0	3.1	NO
ET	TECHNICAL DIRECTIVES ALLOW	9.2	8.0	6.4	6.4	6.0	6.5	NO
ORBITER	STUDIES AND ANALYSIS (40 EP'S)	5.8	6.1	6.3	6.6	6.9	7.2	YES
ENG	NAVIGATION CONTROL AND AERONAUTICS (NEW SOFTWARE DEFINITION & DEVELOPMENT: GPS/DTO, BASIC ASCENT GUIDE, ASCENT ANALYSIS)	5.4	5.7	6.0	6.2	6.5	6.8	YES
ENG	TRACKING & COMMUNICATION (ELECTROMAGNETIC EFFECTS-NEW & IMPROVED H/W)	0.2	0.2	0.2	0.2	0.2	0.2	YES
ENG	PROPULSION & POWER (ORBITER ENHANCEMENT TESTING)	1.8	1.9	2.0	2.1	2.2	2.3	YES
ENG	PROPULSION & POWER (P/L TEST SPT: EVALUATION TEST OF IMPROVED COMPONENTS)	0.3	0.3	0.3	0.4	0.4	0.4	YES
ENG	AUTOMATION & ROBOTICS (FLIGHT CREW EQ DEVELOPMENT)	0.1	0.1	0.1	0.1	0.1	0.1	YES
SUBTOTAL		29.1	24.6	24.0	24.8	25.3	26.6	
PROPOSED IN 91-1 RECOMMEND								
GSME	ATD IMPLEMENTATION	14.6	68.9	87.6	77.9	72.5	67.3	
TOTAL		43.7	93.5	111.6	102.7	97.8	93.9	